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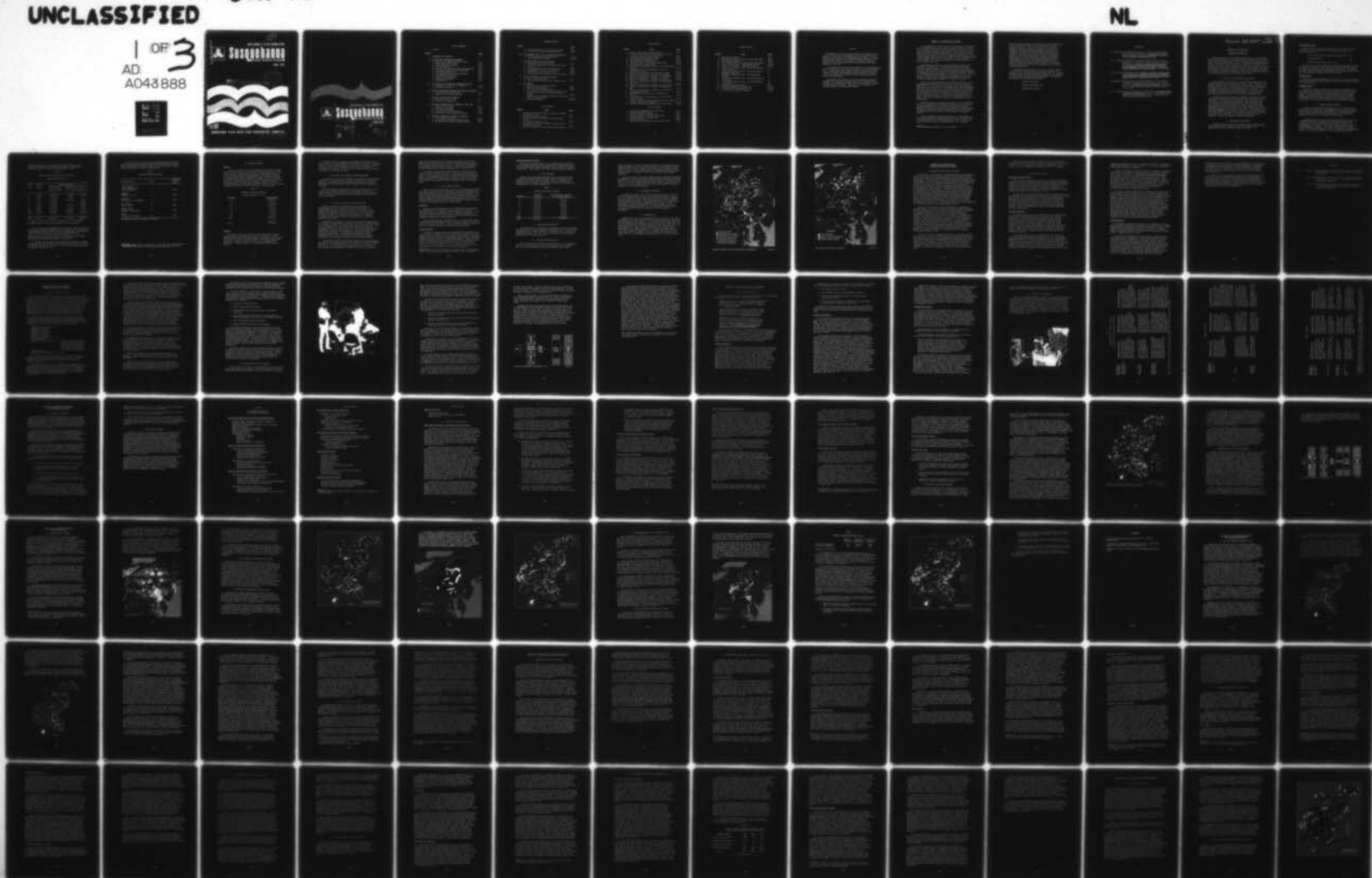

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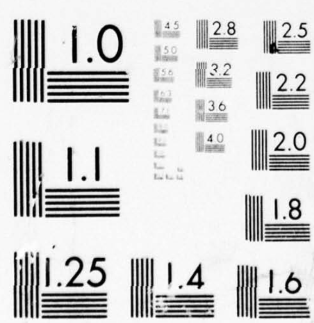

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SUPPLEMENT A–PLAN FORMULATION

Susquehanna RIVER BASIN STUDY

JUNE 1970

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SUSQUEHANNA RIVER BASIN STUDY COORDINATING COMMITTEE

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SUPPLEMENT A—PLAN FORMULATION,

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Preface

Supplement A of the Main Report focuses its attention on the process of formulating a comprehensive plan for the water and related land resources of the Susquehanna River Basin. It covers primarily the activities of the Plan Formulation Workshop, whose responsibility included the analysis of alternative means of meeting the water and related land resource needs of the Basin through the year 2020.

The contents of this volume were selected to provide background on the rationale for including key features in the comprehensive plan. To solve most water resource problems, present and future, a number of choices are available--choices that must be made in light of the broad public interests and the planning objectives selected for this Study.

The authors, the Chairmen of the Plan Formulation Workshop, intended that Supplement A resemble more of an overview of the evolution of a comprehensive plan rather than a technical treatise on complex systems analysis. Hopefully, it will provide the intended insight into the planning process.

CHAPTER I - BACKGROUND FOR PLANNING

The comprehensive study of the water and related land resources of the Susquehanna River Basin began in earnest in 1963. At this time, Americans were becoming more and more concerned about the use of their natural resources. The impact of this concern, not fully apparent during the early planning efforts, was becoming clearer by 1966 when plan formulation for the Susquenanna first started. The recent planning efforts in the water resources field, heavily weighted toward "market-place" values, were losing validity as planning models; changes in priority were calling for new approaches to the plan formulation process.

Plan formulation plays a vital role during the climax of a comprehensive effort such as the Susquehanna River Basin Study. It is the complex process of synthesis, not only of a wealth of technical data on resource supply, demand, and alternative solutions to resource problems, but also of the judgments and sensitivities of the individual disciplines brought to bear for the purpose. Not the least of influences on the process is the perception of what the people of the Basin want, a perception tempered by the necessity to serve a broader public interest, the Nation as a whole.

While the planning process must consider the economic, social, and environmental conditions and trends of the Nation, it must consider as well those of the region under study. The Susquehanna River Basin, in that context, is a "region," with many "subregions" well below the economic and social level of the rest of the Nation. While the region contains areas greatly disturbed by past misuse of resources and in need of restoration, it also has natural areas not yet despoiled that must be saved for future generations to enjoy. The varying conditions found in the subregions, and in the region, formed a major part of the planning background for the Susquehanna.

Equally important in the planning process are the legislative and policy guidelines established by Congress over the years, and extended by agreements and directives of the several Federal agencies involved in water resources development. These guidelines (outlined in Appendix A) are the outgrowth of the previous needs and experiences of the Nation in the development of its water wealth.

At the beginning of plan formulation for the Susquehanna, two of the most significant documents containing specific policy were the "Green Book" 1/* of the Federal water resource agencies, and Senate Document 97 2/ and its Supplement 3/. Two additional

*Numbers indicate references at end of chapter.

documents greatly influenced a redirection of plan formulation as it got underway in 1966. One, "Alternatives in Water Management" 4/, of the Committee on Water of the National Academy of Sciences, greatly strengthened the resolve to examine the broadest practicable range of alternatives and to attempt to increase public involvement in the planning decisions. The other, the report of the Civil Works Study Board 5/ of the Corps of Engineers, triggered an in-depth reappraisal of the broad objectives and policies pertinent to the Susquehanna Study. The immediate impact of these two documents, in the light of Senate Document 97, was to require a significant "mid-course correction" in the conduct of the Susquehanna Study, since both demonstrated the need for planning innovations.

Such, then, was the climate of policy and public interest late in 1966 that influenced the decision to develop a new approach to plan formulation for the Susquehanna. The outgrowth of this decision, as later chapters will show, was the adoption of a three-prong approach for the Susquehanna. The prongs or broad goals, were simplified and titled:

- Economic efficiency,
- Regional development, and
- Environmental quality.

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1. Subcommittee on Evaluation Standards. Report to the Inter-Agency Committee on Water Resources. Proposed Practices for Economic Analysis of River Basin Projects. Washington, D.C.: Government Printing Office, 1958.

2. U.S. Congress, Senate, The President's Water Resources Council together with a Statement by Senator Clinton P. Anderson of New Mexico, Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources, S. Doc. 97, 87th Cong., 2d sess., 1962.

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4. Committee on Water, Division of Earth Sciences, National Academy of Sciences--National Research Council. Report of the Committee. Alternatives in Water Management. Washington, D.C.: National Academy of Sciences--National Research Council, 1966.

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CHAPTER II - EXISTING AND PROGRAMMED DEVELOPMENT

Before beginning the plan formulation process for the Susquehanna Basin, some adjustments in the data on resource supply had to be made to account for the ability of completed improvements to meet water-based needs. Water resource projects, such as reservoirs and sewage treatment plants, that would be under construction or definitely committed to construction by the "zero" planning year 1970, were assumed to be already completed and operating for planning purposes. This chapter outlines the existing and programmed water and related land resource developments in the Basin. Most have a significant, or at least measurable, effect on the relationship between resource supply and demand.

A. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Over 65 percent of the Basin's 3.5 million people and most of its industry depend on public water supply systems. The 550 public water systems now operating in the Basin deliver an average of 600 million gallons of water a day. About one-third of this is from ground water; the remaining two-thirds is from surface sources. There are 322 existing or programmed water supply reservoirs in the Basin listed in Appendix F, Water Supply and Water Quality. Only 33 of these are on streams with more than 25 square miles of drainage area.

In addition, there are two major pipelines constructed to divert water from the Susquehanna system to communities adjoining the Basin (see Figure 1 at the end of this chapter). One takes water from Octoraro Creek in southern Pennsylvania to serve the Chester area to the east. This line withdraws 30 million gallons daily (mgd) into the adjacent Delaware River Basin, with no return flow to the Susquehanna. The other, a 35-mile line from the Conowingo Dam pool, serves to supplement the Baltimore City supply. This pipeline is only used when Baltimore's other reserves are low. Its present capacity is 125 mgd, about one-half of its presently authorized 250 mgd limit. The waste water is returned to the upper Chesapeake Bay near Baltimore. Appendix F provides additional information.

B. AGRICULTURAL WATER SUPPLY

The agricultural water use in the Basin can be classified into rural domestic water, livestock water, and irrigation water. See Appendix F for a more detailed description of each.

Rural Domestic Water

Rural domestic consumption was estimated at 50 gallons per day per person in 1960 or nearly 19 billion gallons per year. The developed sources are:

Public water systems or private water companies	59%
Individual wells	34%
Other (springs, creeks, ponds, etc.)	7%

There is only a slight variation in types of sources from one part of the Basin to another. The southern portion takes somewhat more of its water from individual wells than from other sources. It contains the major agricultural area of Pennsylvania, and a large number of farm and rural non-farm households have individual wells.

Livestock Water

There is limited information on the sources of water for livestock. Annual livestock water usage throughout the Basin was estimated at about 6.5 billion gallons.

Irrigation Water

Sources of irrigation water include streams, on-farm reservoirs, and ground water. Surveys in 1964 and 1966 showed that about 16,230 acres were under irrigation, with streams serving as the principal source. The estimated yearly irrigation water use for an average rainfall growing season was just under 6 billion gallons, based on 1960 demands. The use during a drought with a frequency of once in 5 years, at 1960 levels, would increase to nearly 8 billion gallons.

C. GENERAL OUTDOOR RECREATION

In 1960, the Susquehanna River Basin had about 101,400 acres of water surface including lakes, impoundments, and the area of the Main Stem and major tributaries of the Susquehanna. An estimated 64,800 acres, about 64 percent, were accessible to the public and had a seasonal capacity of over 25 million recreation days

Additional water surface area programmed for development by 1980 (underway in 1970) will increase the total surface area to about 116,800 acres, of which 79,800 acres, or nearly 68 percent, will be accessible to the public. These public access waters should have a summer seasonal capacity of 29 million recreation days in 1980; nearly 34 million recreation days in the year 2000; and over 38 million days by the year 2020. Appendix G, Part 1, Recreation, provides

detailed tabulations of the present and projected supply. Table 1 lists the surface supply and recreation capacity by sub-basins (outlined in Figure 1) as they are anticipated in 1980.

TABLE 1

WATER-BASED RECREATION SUPPLY AND CAPACITY

ASSUMED AVAILABLE BY 1980

Sub-basin	Acres of Surface	Seasonal Capacity		
		Water-oriented Recreation Days	Boating Activity Days Restricted*	Boating Activity Days Unrestricted**
I	16,395	2,803,400	746,500	156,100
II	2,564	857,100	64,000	0
III	20,312	4,143,800	1,991,300	104,100
IV	4,551	1,814,600	0	237,600
V	10,415	5,120,700	1,171,900	288,100
VI	10,602	4,530,700	436,800	531,200
VII	22,815	3,092,300	4,425,300	84,000
VIII	29,123	6,566,400	934,100	1,538,700
Total	116,777	28,929,000	9,769,900	2,939,800

*1 Surface area of 200-500 acres; motors less than 20 horsepower.

**2 Surface area of over 500 acres; motors over 20 horsepower.

Of the 116,800 acres programmed for the Basin by 1980, 32,800 acres would support restricted boating, and an additional 53,800 acres would be unrestricted, without regard to public accessibility. The restricted surface capacity in boating activity days, anticipated to be about 9.8 million in 1980, is expected to increase to 11.4 million activity days in 2000, and to nearly 13 million days by 2020. Table 1 also shows the restricted 1980 capacity by sub-basin.

The 53,800 acres of unrestricted surface should permit 2.9 million boating activity days in 1980, 3.4 million days in 2000, and an expected 3.9 million days by 2020. See Table 1 for the unrestricted capacities by sub-basin assumed for 1980.

Six stream reaches, all within the Pennsylvania portion of the Basin, also have been identified* as having particularly outstanding value for white-water canoeing. Table 2 lists the reaches, location, length, and capacity for such recreational use.

TABLE 2

WHITE-WATER CANOEING REACHES

Stream and Reach	Miles	Canoeing** Activity Days
Black Moshannon: Black Moshannon Dam to SR 53 Bridge	19	5000
Moshannon: Winburne to SR 53	19	6800
Loyalsock: US Route 220 to Hillsgrove	23	8500
Beech Creek: Kato to Mouth	27	9800
Fishing Creek: Benton to Orangeville	19	7200
Muncy: US Route 220 to Mouth	23	8500

**Included in figures in column 3 of Table 1.

*Appalachian Water, Water F. Burmeister. Volume One. Published privately by members of The Canoe Cruisers Association, Washington, D.C. 1962.

D. FISH AND WILDLIFE

Fishing

Fishery resources, varied in availability throughout the Basin, consist of three groups: (1) cold water tributary streams; (2) warm water reaches of major tributaries and the Susquehanna River; and (3)natural lakes and man-made impoundments. The resource capacity for fishing under present conditions is shown by sub-basin in Table 3. The fisherman-day figures represent the capacity of all reservoirs completed or underway by 1970, as well as the natural ponds and lakes and the many miles of streams in the Basin. Appendix G, Part 2, Fish and Wildlife, provides added information on the fishery resources, including the high value cold and warm water fishing streams.

TABLE 3

RESOURCE CAPACITY FOR FISHING

ASSUMED AVAILABLE BY 1980

Sub-basin	Fisherman-Days
I	2,169,000
II	484,000
III	1,188,000
IV	480,000
V	1,261,000
VI	753,000
VII	1,703,000
VIII	1,933,000
Total	9,971,000

Wildlife

The Basin's wildlife resources can be divided into six types: big game, forest small game, farm small game, water-fowl, other migratory birds, and fur-bearing animals. Distribution and abundance of the various types are closely related to the habitat supporting each group. Changes in habitat will continue as farmlands in some parts of the Basin revert to forest and as existing forests mature.

Waterfowl habitat, including the programmed development of new water surfaces, is particularly limited throughout the Basin. Exceptions include the Whitney Point Reservoir in New York (see Figure 1) and the area at the mouth of the Susquehanna, near the upper reaches of Chesapeake Bay. Appendix G, Part 2, also contains detailed information on wildlife distribution and trends.

E. MUNICIPAL AND INDUSTRIAL POLLUTION ABATEMENT

As of 1970, organic wastes originate from 110 municipal waste-water systems and 20 major industrial discharges (Appendix F). Thirty-two waste service areas now have no treatment and 46 have only primary treatment; the remainder either have secondary treatment underway or completed.

The existing State water pollution control laws and water quality criteria for interstate streams call for secondary treatment of organic wastes at all urban areas. An exception is made in Pennsylvania on those streams which are severely degraded by pollution from coal mine drainage.

F. COAL MINE DRAINAGE POLLUTION ABATEMENT

Current legislative regulations for the coal industry in Pennsylvania, where the Susquehanna mine drainage problem is concentrated, are among the most stringent in the Nation. Hence, drainage from presently operating coal mines is now largely under control. The problem of drainage from abandoned coal mines and the related problems of surface blight, mine fires, subsidence, and economic retardation of affected communities are of principal concern in this report.

Pennsylvania's Department of Health has developed "Pennsylvania's Ten Year Mine Drainage Pollution Abatement Program for Abandoned Mines" as a cooperative effort with several State and Federal agencies. Phase I of the program is the location of pollution sources; Phase II, engineering studies and plans; Phase III, construction of facilities; and Phase IV, operation and maintenance. In the Susquehanna River Basin, Phase I and Phase II are about 80 percent and 25 percent completed, respectively. The Department of Health has direct responsibility for enforcing standards set by the State Sanitary Water Board on the quality of discharges from active deep mines.

The Department of Mines and Mineral Industries of the Commonwealth can construct and operate plants for the abatement of coal mine drainage pollution and can charge operators for treatment of discharges from their mines. The Secretary of the Department also has the power and the right to enter any property to combat a mine fire, refuse bank

fire, or mining subsidence, and to conduct remedial action at the expense of the property owner whenever an emergency condition exists. The Department has also begun a number of engineering investigations on Susquehanna Basin watersheds, namely: Beech, Rausch, Shamokin, Kettle, Trough, Swatara, Upper Lackawanna, Alder, and Muddy Creeks.

The Federal Water Quality Administration has initiated a broad research program, including research by its own staff and support of research and development by industry, universities, and State governments. In the Susquehanna Basin it is helping to fund three projects being implemented by the Department of Mines and Mineral Industries on tributaries of the Bennett Branch, Moshannon Creek, and Catawissa Creek.

G. FLOOD DAMAGE REDUCTION

Most of the major flood damage centers in the Basin already receive some degree of flood protection from major upstream reservoirs and/or from local protective works. In addition, many rural and smaller urban areas receive flood protection from upstream watershed projects. An existing flood warning and evacuation system, described in Appendix E, assists communities to avoid recurring flood damages, while a very limited, locally administered flood plain management program is working to restrain the gradual increase in flood losses.

Reservoirs

The Army Corps of Engineers and the Commonwealth of Pennsylvania have completed or have underway 17 major reservoirs* within the Susquehanna Basin that contain specific flood control storage. Figure 1 at the end of this chapter shows their location and Appendix E provides a complete list of all Federal and State reservoir projects considered completed for planning purposes.

The total drainage area controlled by the 17 major flood control reservoirs assumed completed is about 3,660 square miles or 13.3 percent of the total area of the Basin. These reservoirs include a total of just over 1,050,000 acre-feet of storage for flood control.

Local Protection

The Corps of Engineers and the Commonwealth of Pennsylvania have either underway or completed 36 and 24 local flood protection projects, respectively, in the Basin. These projects include levees, flood walls, pressure conduits, spoil dikes, interceptor drains, culverts, pumping stations, and several types of channel improvements. Levees and flood walls are designed to protect against at least the largest flood of record, with additional capacity to protect against overtopping. Figure 1 shows the location of the major projects; the full list of both Federal and State projects can be found in Appendix E.

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*Each controls over 35 square miles of drainage area; if the drainage area is less, the dam is at least 90 feet high at the streambed.

Upstream Watershed Projects

The Soil Conservation Service, U.S. Department of Agriculture, has 19 upstream watershed projects completed or underway that cover a total of 880 square miles of headwater areas, or about 3.2 percent of the Basin. These projects and their status are shown on Figure 2.

H. LAND TREATMENT

Present land conservation programs within the Basin are aimed primarily at initial treatment and protection of the publicly and privately owned lands within the Basin. Table 4 summarizes the present status of on-going land treatment programs in each sub-basin. See Appendix J for further information.

TABLE 4

PRESENT LAND TREATMENT STATUS

Sub-basin	Total Area (Acres)	Area adequately treated or not needing treatment
I	3,156,000	1,382,000
II	1,648,000	650,000
III	2,341,000	1,016,000
IV	1,878,000	634,000
V	2,569,000	905,000
VI	2,167,000	762,000
VII	1,370,000	527,000
VIII	2,278,000	6,753,000
Total	17,407,000	12,629,000

I. STREAMBANK STABILIZATION

The Commonwealth of Pennsylvania, Department of Forests and Waters, has completed 25 streambank stabilization projects, and will have eight additional projects newly completed or underway in 1970. Appendix B, Pennsylvania Report, lists the location and status of these projects and the length of stream protected.

J. ELECTRIC POWER PRODUCTION

With few exceptions, electric power production in the Susquehanna Basin has been developed and operated by privately owned utilities. There are 12 existing hydroelectric installations with a total

installed capacity of about 1,643,000 kilowatts, and a combined average annual generation of 3.4 billion kilowatt-hours (see Appendix H, Power). Nearly all (98%) of this capacity is located on the lower Main Stem at the four largest separate installations, including the Muddy Run pumped storage project. See Figure 1 for the major hydroelectric station locations.

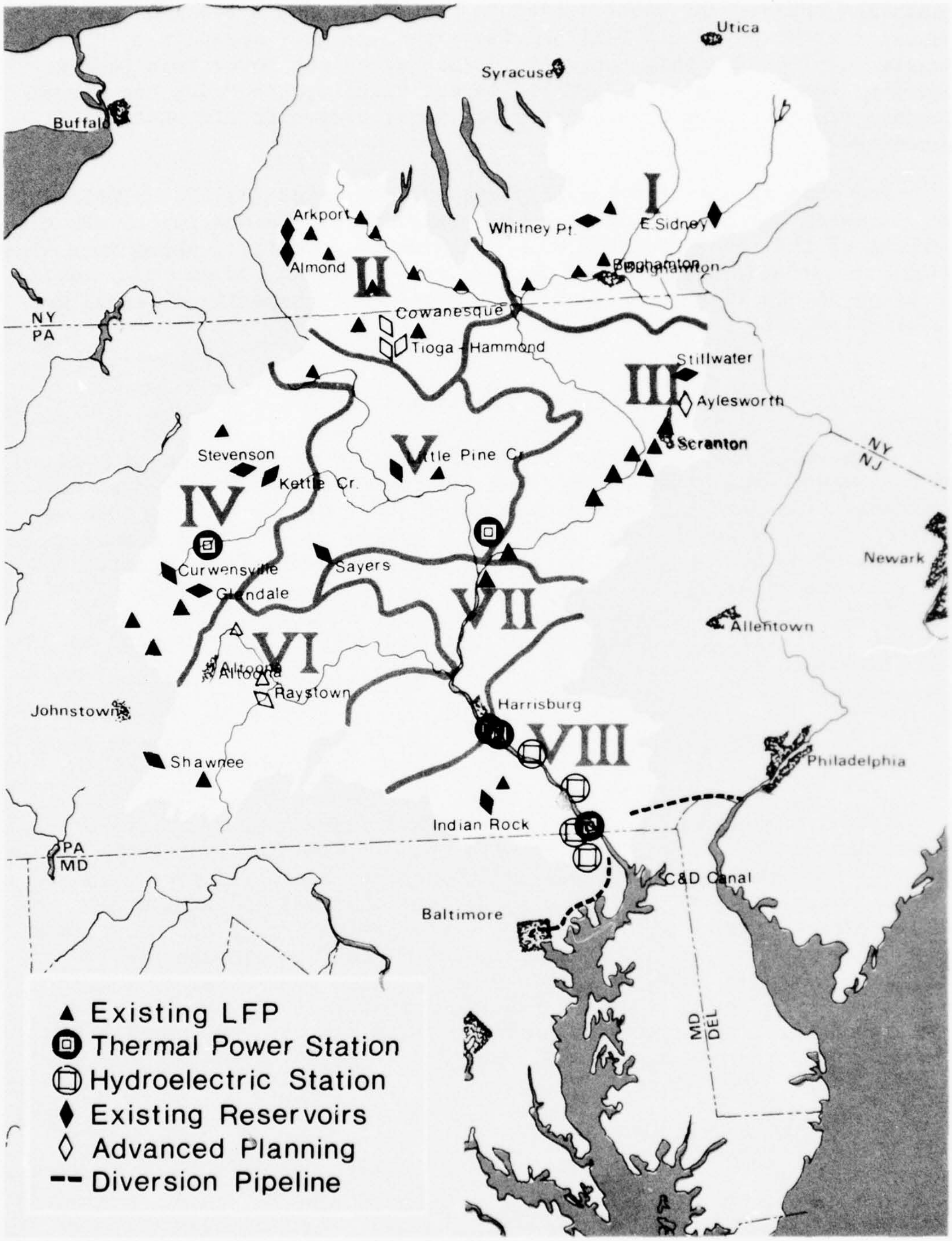
The thermal-electric capacity assumed completed (8,559,000 kilowatts) predominates the power production from all sources, amounting to about 85 percent of the total electric power generating capacity. Appendix H also lists the principal thermal plants and their status. Figure 1 shows the location of the five largest stations, those with capacity existing or underway of over 500,000 kilowatts.

K. COMMERCIAL NAVIGATION

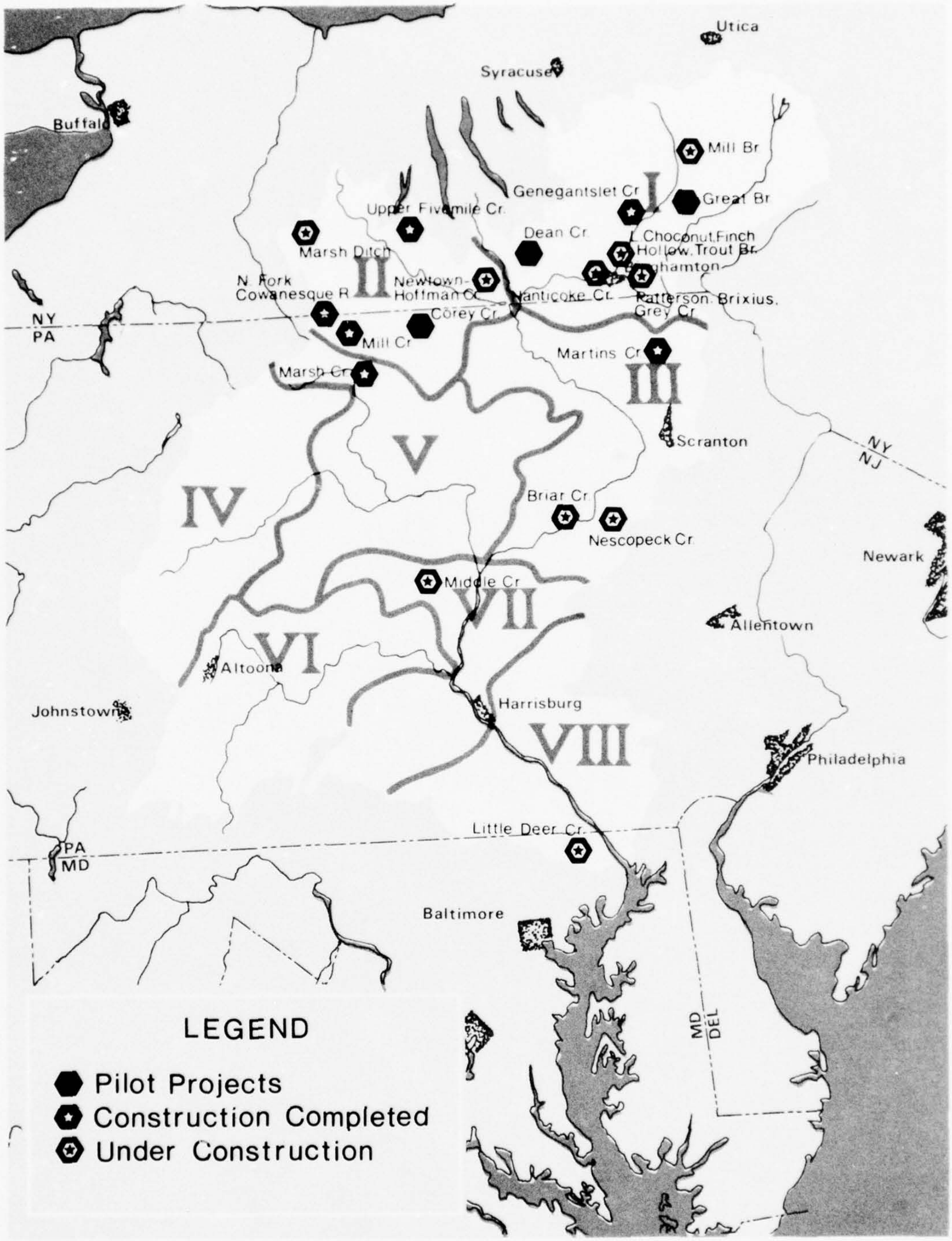
Commercial navigation was once the dominant use of the Main Stem of the Susquehanna River and most of its larger tributaries. Much of the early transport was on the open river and later along an extensive system of canals and locks. This entire system as a vein of commerce has long since been replaced by more efficient means of transportation. The remnants of navigational development have no impact on plan formulation under this heading; they are best remembered as part of the cultural heritage of the Basin. The hydroelectric power dams on the lower Main Stem contain no facilities to allow passage of navigation.

L. CHESAPEAKE BAY

Below the mouth of the Susquehanna River, the estuary of the upper Chesapeake Bay is linked directly with the Delaware Bay by the Chesapeake and Delaware Canal (see Figure 1). The present canal (27 feet deep and 250 feet wide) is being enlarged to 35 feet deep and 450 feet wide. The tidal characteristics of the two estuaries are such that the new flow of water through the C and D Canal is eastward--to the Delaware Bay. Enlargement of the canal is expected to increase the amount of water lost from the upper Chesapeake, from the present 700-1,000 cubic feet per second (cfs) net average rate to an estimated net average rate of 2,200-2,700 cfs. See Appendix B, Maryland Report, for futher information.



MAJOR PROJECTS AFFECTING WATER RESOURCES Figure 1



UPSTREAM WATERSHED PROJECTS

Figure 2

CHAPTER III - THE PATTERN OF PROBLEMS AND SYSTEMATIC ANALYSIS

A. DETERMINING THE PATTERN OF PROBLEMS

An early step in the process of plan formulation is the comparison of resource supply with the resource demand, both projected into the future, to determine the location, magnitude, and timing of resource deficiencies. These deficits in resource availability, variously termed "requirements" or "needs," form a systematic pattern that changes with the passage of time. The essential characteristics of place, size, and time of a projected deficit will, of course, be sensitive to the predicted rate of growth in resource demand and the predicted quality and availability of the resource. This sensitivity increases sharply as projections move farther into the future. Included in this concept of comparison are such requirements as water supply for farms, communities, and industries (including thermal-electric power production), as well as water-based outdoor recreation, and fishing and wildlife use. To some extent, hydroelectric power production and commercial navigation also constitute a "use" of a water resource. In these two cases, the demand for the respective products of electric power and transportation can be met by alternative means that affect primarily the price of the project and not the product itself.

Also part of fixing the pattern of problems is the extent of resource "protection" required. Maintaining stream quality standards and minimizing all types of pollution of the water resource fall into this general category, as well as reducing flood damages, land conservation requirements, and control of excessive streambank erosion. All affect the quality of the resource base to some extent, and can be related in place, size, and time with varying degrees of reliability and impact on systematic analysis. All the significant resource "use" and "protection" problems can be superimposed at convenient future points in time (1980, 2000, and 2020 were selected for the Susquehanna Study) to develop a system of resource shortages or "needs." The basic information on resource supply and protection problems may require adjustment, as indicated in Chapter II, to account for development which for planning purposes is assumed to be at least underway by 1970.

To assist in making formulation decisions in each sub-basin, for projected points in time, a requirements system map was constructed. The information for this map was gathered from requirements or "needs" tables which summarized and consolidated the comprehensive data now published in the appendices. These tables also helped simplify the complex process of relating supply and demand for each sub-basin. Attachment 1 (Chapter XI) contains a summary table that is representative of the kind of information used in the requirements system map.

The collection, evaluation, and projection of the demand for each specific category of water or related land resource are explained in some detail in the appropriate appendix. Appendix A, Study History, contains a summary of the process used for all categories.

B. SYSTEMATIC ANALYSIS

Analyzing the River System

Before the plan formulation phase began, substantial effort had already been directed toward developing improved methods of systematic analysis of resource requirements and alternative solutions. Serious difficulties arise when the complex and variable hydrology of the river system, during both drought and flood flow conditions, is related to examining a wide range of alternative solutions to resource problems that change with the passage of time.

An early decision was the selection of computer simulation as the most effective basic technique for the analysis of complex river systems. Its use during plan formulation was expected to be preceded and supplemented by hand and desk methods, particularly in narrowing the range of alternative solutions to be examined in detail. But even with the advances in computer capabilities, it was impracticable to analyze simultaneously both the low flow and the flood systems. These two hydrologic conditions were modeled separately for later combination.

Low Flow Conditions

As indicated earlier in this chapter many of the water resource problems in the Susquehanna system are related to the natural inadequacies of drought streamflow to meet quantitative needs. Even if all problems of resource degradation, natural and man-induced, were to be eliminated, problems of inadequate supply would still remain that require solution. In some way, added quantities of water must be made available to meet the anticipated, even if infrequent, low flow conditions. Beyond a decision for non-use, import of water from more plentiful sources, or temporary withdrawal from reserve storage, above or below ground, must be critically examined.

The computer model used for simulating the more complex low flow conditions was developed with the assistance of the Hydrologic Engineering Center of the Corps of Engineers. 1/ The basic program accounts for flows in an assigned network of storage reservoirs, diversions or consumptive losses, and control points, over a specified sequence of time increments. A number of modifications were made during plan formulation to better adapt the model to the specific problems of low flow conditions in the Susquehanna River system. The

program will operate to meet the streamflow, diversion, or consumption requirements throughout the entire Basin, or in isolated combinations of the eight hydrologic sub-basins.

Testing the adequacy of a selected system of measures, particularly combinations of reservoirs operating together, is primarily a guided trial and error procedure. In simulation, progressive adjustments must be made in a given combination until the system either meets its design requirements in an optimum manner or reveals its extent of failure. Use of the computerized simulation technique, while not all-encompassing, does allow analysis of a larger number of potential solutions to complex problems in a given period of time. It also has the potential to better reveal river system limitations during critical conditions of low flow, either with or without the mitigating effect of flow regulating measures.

The lack of detailed information on the fresh water flow requirements to maintain the desirable ecology of the upper Chesapeake Bay, and the unknown impact of changes in the flow pattern, forced systematic analysis of the problem to the later stages of plan formulation when projected patterns of streamflow change would become clearer. The future irrigation losses, when added to the expected consumptive loss of part of the water withdrawn for municipal and industrial uses (including the quantity of water lost during evaporative cooling for power production), when further added to the diversions of water out of the Basin, together could mean a substantial reduction in natural fresh water inflow during critical dry months. The simulation model had to be sufficiently large and flexible to be able to analyze adequately this complex problem of flow losses from the total Susquehanna River Basin system. The model also would be called on to examine the impact of alternative solutions to minimize the change in the natural pattern of flow into the upper Bay.

Flood Conditions

An additional simulation requirement, not performed by the basic accounting model noted above, is the analysis of flood events. Separate digital computer programs were available or developed to estimate the characteristics of potential floods, and to evaluate the probable effect of alternative systems of reservoirs on the frequency of flood stages at downstream damage centers.

To assist in the simulation of flood events, a representative basin-wide flood was developed for the Susquehanna River at Harrisburg, Pennsylvania. Comparison of flood peaks that have actually occurred in the upstream hydrologic sub-basins (I-VI in Figure 1) with those resulting from computation of the basin-wide flood showed that the relative severity of the upstream regional floods would not be adequately reflected. Representative floods also were developed for upstream hydrologic sub-basins where needed to augment the station on the Main Stem at Harrisburg. Rainfall amounts for these floods were derived using data from "Hydrometeorological Report No. 40", U.S. Weather Bureau, Washington, May 1965, and H.E.C.

Computer Program No. 23-J2-L228. 2/ Using rainfall loss rates presented in Appendix D, computed rainfall excesses were applied to individual unit hydrographs for 138 sub-areas. Flood hydrographs so determined were then routed and combined for total flow at downstream damage centers above each key gaging station using H.E.C. Computer Program No. 23-J2-L232. 3/

To cover the range of interest for plan formulation purposes, five floods were routed as differing percentages of the representative flood above each key station. The modifications by reservoirs of the flood hydrographs so determined were consistent with modifications using actual flood hydrographs. Detailed information on unit hydrograph development and flood routing procedures used for the flood control system analysis is presented in Appendix D.

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1. H.E.C. Computer Program No. 23-X6-L253 "Reservoir System Analysis," December 1968, U.S. Army Engineer District, Sacramento, California.

2. H.E.C. Computer Program No. 23-J2-L228, "Unit Graph and Hydrograph Computation," July 1966, U. S. Army Engineer District, Sacramento, California.

3. H.E.C. Computer Program No. 23-J2-L232, "Hydrograph Combining and Routing," August 1966, U.S. Army Engineer District, Sacramento, California.

CHAPTER IV - THE PLAN FORMULATION WORKSHOP AND PLANNING APPROACH

A. THE PLAN FORMULATION WORKSHOP

The principal effort on the Susquehanna Study, prior to the spring of 1966, had been devoted to collecting and evaluating the basic data to support plan formulation. The Chairman of the Susquehanna Coordinating Committee called a special meeting in April 1966 to discuss the objectives and general procedures that would be used for plan formulation. At the meeting, the Executive Secretary, recognizing the need for a separate group, recommended that a Plan Formulation Workshop be created. This group would work within the context of the Coordinating Committee, but would not be formally designated as a Subcommittee. The Workshop's comprehensive plan for the Basin would be presented to the Coordinating Committee for review and comment at appropriate intervals.

The Coordinating Committee agreed that the persons attending the Plan Formulation Workshop meetings would include those professionals with the necessary information and background knowledge to put together a comprehensive plan. The group would be limited, if possible, to about 20 persons, and be composed of the following representatives:

Department of Agriculture	3	
Department of the Army	2	
Department of Commerce	1	
Federal Power Commission	1	
Department of Health, Education and Welfare	1	
Department of Housing and Urban Development	1	
Department of the Interior	6	(1 each from Bureau of Mines, Bureau of Sport Fisheries and Wildlife, Bureau of Outdoor Recreation, U.S. Geological Survey, and 2 from Federal Water Quality Administration)
States of New York, Pennsylvania, and Maryland	1 or 2 each	

The Corps of Engineers would provide the Chairman to manage the meetings and would record the essential notes and data. No formal minutes of Workshop meetings would be prepared for Coordinating Committee circulation.

The directive to the Workshop to formulate a comprehensive plan emphasized from the beginning that the workshop would be as independent of the Coordinating Committee as practicable. It was also recognized that the Workshop would only make recommendations to the Coordinating Committee; the plan to be recommended in the final report would be the plan adopted by the Coordinating Committee.

The broad goals or objectives for project and plan formulation were also discussed at this special Coordinating Committee meeting, particularly the objectives of Senate Document 97. Stated briefly, they are: to formulate plans to meet short and long term water resource needs as a means of providing national and regional economic development; to preserve, protect and rehabilitate unique resources to assure their availability for their best use when needed, and for recreation, inspiration, enjoyment, and education of the people; and to recognize the well-being of all the people as the overriding determinant in considering the best use of resources.

The Coordinating Committee also noted that the plan should be technically feasible, that is, be compatible with current technology, and be flexible enough to accommodate future technological developments. It should also be economically desirable with a favorable benefit-cost ratio and should approach maximization of excess benefits based on total benefits rather than just primary benefits. The plan should not preclude more economical means of accomplishing the same purposes. It should also be publicly and politically acceptable so as to maintain a reasonable chance of being implemented. Other objectives mentioned were that the plan should be for the entire Basin rather than an agglomeration of plans for sub-basins or States. The plan should avoid pre-conceived notions as to dominant and add-on purposes so that each water resource service would be fully considered and provided for where it is needed in the desired amount and quality.

It was also noted at the special Coordinating Committee meeting that plan formulation would be completed in three phases: Phase I, the assembly of all information for "screening"; Phase II, the process of screening alternatives; and Phase III, the selection of viable alternatives for refinement.

The result of Phase I was to be (1) a complete inventory of all needs, quantitative and qualitative, throughout the Basin, (2) the general magnitude of the annual monetary benefits realized by satisfying the needs, (3) a complete inventory of all resource development possibilities, and (4) the annual costs for a range of development for each. A portion of Phase I had been completed prior to the April 1966 Coordinating Committee meeting as indicated in the preceding chapters.

The intent of Phase II was to reduce the alternatives to a manageable number composed of those that offered some promise for inclusion in Basin development plans, especially for early action (by 1980).

Phase III was to be a sub-basin by sub-basin comparison of needs and resource development opportunities, and the selection of combinations of projects and measures that appeared most desirable for further refinement. Selections were to be made for at least two future points in time, including the limit year 2020.

Following the April 1966 Coordinating Committee meeting, the Plan Formulation Workshop was established and its Chairman instructed to proceed with plan formulation in accordance with the objectives mentioned and the structure agreed upon by the Coordinating Committee.

The first meetings of the Workshop, in July and August of 1966, dealt primarily with the progress of data assembly and evaluation. Agency participants were assigned tasks to prepare further information on the needs and alternative solutions. The Workshop also opened up discussion and thought concerning the great range of plan formulation possibilities, including:

1. No specific development plan.

2. Satisfy State planning criteria.

3. Most efficient plan to meet desirable and feasible objectives.

4. Meet different needs, showing the cost and effect of various development levels, short of satisfactory measures.

5. Plan to stimulate economic opportunity.

6. Maximum definable development of resources.

The Workshop participants, while widely divergent in their individual views on planning, did agree that items 1 and 6 of the above list represented extremes that the Workshop could not recommend to the Coordinating Committee. A "reference" or "somewhere-in-between" plan would be required. To serve as a base point for plan formulation, and as an intermediate reference against which to compare subsequent plans, the Workshop agreed to pursue a "base" or "reference" plan concept. A "base plan" would be formulated to realize a feasible level of needs satisfaction in the apparent most efficient manner. This would also assist in revealing data deficiencies.

Additional meetings of the Plan Formulation Workshop, pending assembly of the required data, were not held until early December of 1966, when work on a base plan actually got underway. However, considerable in-depth discussion of the planning process occurred between the August and December meetings. These discussions resulted in a redirection of the plan formulation process and the introduction of several innovations.

B. OUTLINING THE PLANNING APPROACH

As a follow-up to a report to the Secretary of the Army on the civil works program of the Corps of Engineers, prepared by the Civil Works Study Board (see reference 5 at end of Chapter I), a special


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task force was appointed by the Office, Chief of Engineers in October 1966. This task force was instructed to examine plan formulation in general, and specifically the consideration and presentation of alternatives for the Susquehanna River Basin Study. The Susquehanna was selected for review because, at that time, the Study management was based in Washington and convenient to the task force, and the Study had reached a stage where actual plan formualtion was about to begin.

The review of the special task force at this particular point in the Study had a significant impact on plan formulation. During the meetings of the task force, a completely new objective-oriented approach to plan formulation was suggested, which at this point had not been discussed with either the Coordinating Committee or the Plan Formulation Workshop participants. Three broad objectives of water development in the Basin were identified:

1. Maximize net economic gains and human satisfaction from a regional viewpoint;

2. Maximize net economic gains and human satisfaction from the national viewpoint; and

3. Maximize net economic gains and human satisfactions with minimum disruption of the natural environment.

Initially the Plan Formulation Workshop would formulate a plan generally responsive to the second objective, which was similar to the aim of the "base" plan already agreed upon at the first meetings of the Workshop. Ideally, the next steps in plan formulation would be to formulate plans for the other two objectives.

It was noted at this time that a plan responsive to the third objective would not necessarily preclude construction, but would strive to meet nearly the same level of needs as the other plans with a minimum disturbance of the natural environment. This would require greater use of such alternatives as advanced waste treatment, ground water development, and flood plain management, and might even allow some needs to go unsatisfied in order to preserve a unique portion of the environment.

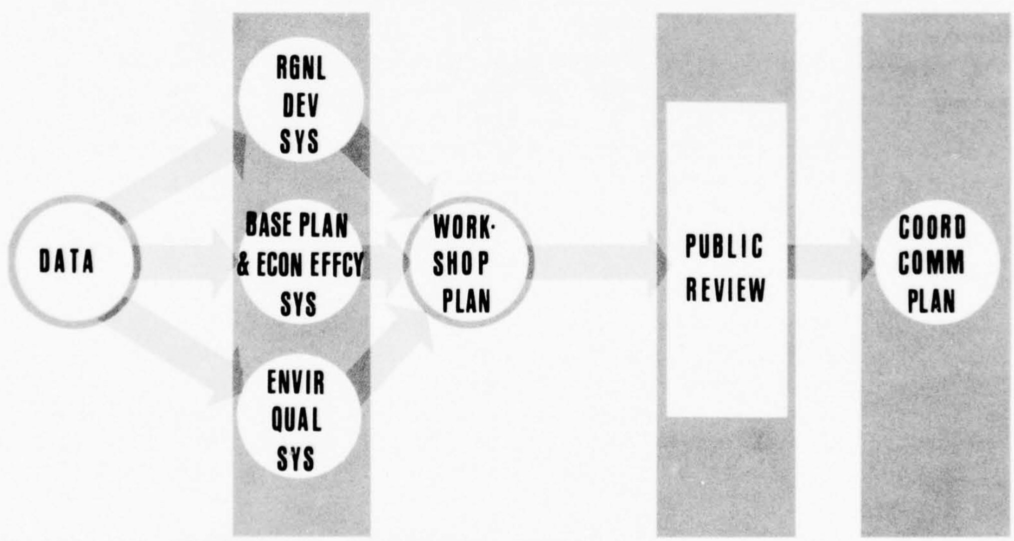
Each plan formulated would differ fundamentally with respect to the individual water resource development and management measures chosen to achieve a certain level of needs. Since full examination of alternatives was the principal concern, additional refinements were not suggested so that the Workshop could concentrate on the impact of the different objectives on the selection of alternative solutions.

The task force and the Susquehanna planning staff did not believe that the Plan Formulation Workshop would have adequate time under the schedule to formulate three complete alternative plans covering all needs. They agreed, however, that the best path would be to start with a base plan which would meet the level of needs specified by

the base plan criteria. Then the Workshop would examine alternatives to select those most responsive to the other two objectives. In this way, a wide range of alternatives would be tested and better understood and used in formulating the recommended plan.

From a practical point of view, the plan finally recommended by the Coordinating Committee was expected to be a blend or combination of the three objectives, choosing as much from each objective as present knowledge and operation of the democratic process would allow.

Following the meetings and discussions with the task force, base plan formulation begin in December of 1966 and continued through most of 1967. (Chapter VI will cover formulation of the base plan.) In January of 1967, the Plan Formulation Workshop Chairman outlined the multiple-objective concept of formulation to the participants, offering it as the overall direction of the plan formulation effort. The presentation was also intended to bring out useful discussion on the concept, and on the essential information that was lacking at that time to be responsive to three differing objectives. The Workshop membership's response to the multiple-objective approach was receptive but cautious; this approach had not been done before.



PLANNING APPROACH-FEBRUARY 1967 Figure 3

The Susquehanna Coordinating Committee, as mentioned earlier, first discussed broad planning objectives as guidance for plan formulation during the April 1966 special meeting for that purpose. The Committee again addressed the question of objectives during their February 1967 closed meeting when the Plan Formulation Workshop chairman first presented to them the multiple-objective approach to plan formulation. This approach called for the formulation of three separate and distinct response systems (loosely, but erroneously, called "plans"*) as a means of enlarging the treatment of alternative solutions to the Basin's water resource problems. During this presentation, the three objectives were also defined and the reasons for their selection outlined to the Committee members for discussion. The Committee members' reactions also were cautious and questioning. Was an innovation requiring repetitive formulation worth the limited time and effort available? The approach may well require collection of data that would not be fully useful. Why not formulate the Workshop's recommendation to the Coordinating Committee directly, keeping the three objectives in mind as a single plan was put together? The Coordinating Committee, although generally agreeing with the objectives defined, did not resolve the question of the planning approach at the February 1967 meeting. Nor did all members concur at that stage of the Study in use of the approach after completion of base plan formulation. Figure 3 illustrates the approach proposed to the Committee. The following chapter defines the three objectives and their planning criteria as they had evolved from their early 1967 definitions.

*The Coordinating Committee members, particularly the State representatives, wished to reserve the word "plan" for their final recommended plan.

CHAPTER V - PLANNING OBJECTIVES AND CRITERIA

A. DEFINITION OF OBJECTIVES

The three broad objectives adopted early in 1967 for the Susquehanna plan formulation effort can be "formally" defined as:

Economic efficiency -- Return the maximum in social and economic satisfaction through investment in water resource restoration and development from the viewpoint of the Nation as a whole.

Regional development -- Return the maximum in social and economic satisfaction through investment in water resource restoration and development from the viewpoint of the region, the Susquehanna River Basin.

Environmental quality -- Return the maximum in social and economic satisfaction through investment in water resource restoration and development, with emphasis on minimum disturbance of the natural environment, and on restoration, preservation, and enhancement of broader environmental values.

These definitions cannot, by themselves, convey full understanding of their significance and differences in the Study; further explanation is in order. Even so, it was never meant that these three objectives would be all-encompassing and widespread in application. They were developed for the Susquehanna by those involved in the Study to help assure that plan formulation would consider the widest practicable range of alternative solutions to water resource problems.

Economic Efficiency

The economic efficiency objective reflects the concern in planning that water resource investment be placed where it will do the most good in the long range for the national economy. When one considers that economic efficiency has formed a firm basis for most Federal water resource planning efforts since the early 1950's, its importance as an established planning objective becomes clear. Both the "Green Book" and, later, Senate Document 97 have influenced past river basin studies, and both indicate national economic efficiency as a base from which significant departures to accomplish other objectives are measured. Although there has been considerable recent criticism of benefit-cost analysis and formulating solely for the economic efficiency objective, a separate response system would be of value even though it would not approach an alternate plan for the Basin.

Guidelines for the economic efficiency response system, as spelled out in the Green Book, would be met if for each feature of a plan:

1. The benefits exceed the costs.

2. Each separable segment is incrementally justified.

3. The scale of development provides a maximum of excess benefits over costs.

4. No more economical means of accomplishing the same purpose is precluded by the project or the plan.

Formulation for the economic efficiency objective, if carried to completion, would result in a response system which maximizes the net return of market-place goods and services from the national point of view.

Regional Development

For the regional development objective, the planning viewpoint shifts from that of the entire Nation to that of the Susquehanna Basin. The basic difference is an attempt to reflect the regional concern from programs of maximum benefit to a selected portion of the country. The Susquehanna Basin includes about 23,000 square miles in the Appalachian area, which is 80 percent of the entire Susquehanna drainage area. One concept of regional development, abstracted from Sec. 2 of the Appalachian Regional Development Act of 1965 (Public Law 89-4) follows:

"The Congress hereby finds and declares that the Appalachian region of the United States, while abundant in natural resources and rich in potential, lags behind the rest of the Nation in the economic growth and that its people have not shared properly in the Nation's prosperity. The region's uneven past development, with its historical reliance on a few basic industries and a marginal agriculture, has failed to provide the economic base that is a vital prerequisite for vigorous, self-sustaining growth....The Congress recognizes the comprehensive report of the President's Appalachian Regional Commission documenting these findings and concludes that regionwide development is feasible, desirable, and urgently needed. It is, therefore, the purpose of this Act to assist the region in meeting its special problems, to promote its economic development, and to establish a framework for joint Federal and State efforts toward providing the basic facilities essential to its growth and attacking its common problems and meeting its common needs on a coordinated and concerted regional basis. The public investments made in the region under this Act shall be concentrated in areas where there is a significant potential for future growth, and where the expected return on public dollars invested will be the greatest. The States will be responsible for recommending local and State projects, within their borders, which will receive assistance under this Act...."

Formulating a response system for the regional development objective was intended to concentrate on geographic areas (growth centers) where the economy could be stimulated by water and related land resource development. One of the difficult problems recognized in selecting this objective was that water and related land resources development is only one of a number of means of stimulating the economy. Its success would depend on the availability of labor and investment in other sectors of development. In spite of these difficulties, both the Appalachian Regional Development Act and Senate Document 97 call for this objective to be included and an attempt made to examine its impact on selection of development measures.

Environmental Quality

A third objective, environmental quality, recognizes the concern for healthy and attractive surroundings. It reflects the importance of preserving scenic, cultural, historical, and wilderness values for the enjoyment of people, and the need for restoring and improving the less healthy and attractive areas -- those scarred by mining, pollution, and improper land use. This objective has gained increasing popularity and concern in the Nation in the last few years, even though agreement on specific criteria is lacking. Although air pollution, highway planning, etc. are beyond the scope of this Study, much of the environment can be related to water resources.

Again referring to Senate Document 97, it requests that full consideration be given to the preservation objective:

"Proper stewardship in the long-term interest of the Nation's natural bounty requires in particular instances that -

> There be protection and rehabilitation of resources to insure availability for their best use when needed. Open space, green space, and wild areas of rivers, lakes, beaches, mountains, and related land areas be maintained and used for recreational purposes; and areas of unique natural beauty, historical and scientific interests be preserved and managed primarily for the inspiration, enjoyment and education of the people."

Environmental quality was further described for the Susquehanna Study as the preservation, restoration, or improvement of the land and water, consistent with expectations of rising income and employment for an expanding population. The term combines both aesthetics and economics. It realizes that some portion of the natural environment will have to be altered to promote economic growth and development. The environment, however, cannot be totally sacrificial to the interests of economic gain. Environmental quality is not a static phrase, however, since it can evolve along with the institutional, technical, and economic values of the particular society which creates the environment and is influenced

by it. The environment may be stationary for a moment in time. Yet, viewed historically, environments by definition do change.

B. CRITERIA FOR FORMULATION

The Plan Formulation Workshop, following the Coordinating Committee's acceptance of the three-objective approach to formulation, agreed on a set of criteria for each of the three objectives. The criteria were developed for each water resource problem or "need" category, making maximum use of criteria agreed upon within the Workshop for the base plan. In several requirement categories, the criteria were vague or could show little or no variation, due mainly to the lack of a range of available data on the separable beneficial effect of the individual measures included. The criteria are summarized by objective in Table 5 on the following pages.

TABLE 5

PLAN FORMULATION CRITERIA SUMMARY

BY OBJECTIVE FOR REQUIREMENT CATEGORIES

Category of Requirement	Economic Efficiency *	Regional Development	Environmental Quality
Water Supply (Municipal and industrial)	Meet projected demands with one failure in 25 years (7-day duration). Include measures most economically efficient as part of a multi-purpose system to meet water resource needs.	Meet projected demands with one failure in 25 years (7-day duration). Added reserves may be included to provide greater flexibility and a more dependable source of industrial supply.	Meet projected demands with one failure in 25 years (7-day duration). Favor pipelines and ground water with natural recharge; reservoir storage on smaller tributaries only if at a site compatible with objective.**
Water Supply (Irrigation)	Meet projected demands with one failure in 5 years (7-day duration) for June through September. Provide most economical source.	Meet projected demands with one failure in 5 years (7-day duration) for June through September. Most economical source may include added reserves.	Meet projected demands with one failure in 5 years (7-day duration) for June through September. Source should be consistent with objective and competing uses.
Water Quality (Biochemical oxygen demand)	Maintain dissolved oxygen level of 5.0 mg/l except one 30-day period every 20 years. Include measures most economically efficient as part of a multi-purpose system to meet water resource needs.	Maintain dissolved oxygen level of 5.0 mg/l except one 30-day period every 20 years. Added reserves may be included to provide greater flexibility of operation; enhance stream use through improving water quality with flow augmentation.	Maintain dissolved oxygen level of 5.0 mg/l except one 30-day period once every 20 years. Favor advanced waste treatment; include limited low flow augmentation from upstream reservoirs on minor tributaries only if site is compatible with objective.*

*The economic efficiency criteria closely approximate the original "base plan" criteria.

TABLE 5 (CONT'D)

Category of Requirement	Economic Efficiency	Regional Development	Environmental Quality
Recreation	Meet as much of projected demand as appears to be economically justified by user benefits. Select measures to maximize net user benefits regardless of location.	Meet as much of projected demand as appears to be economically justified by both user and expansion benefits. Select measures close to growth centers, major highways, etc., to obtain expansion benefits.	Emphasize use of natural streams. Meet as much of demand for boating as feasible at reservoirs compatible with the objective; add low channel dams on main stem and major tributaries at selected sites. Use upstream reservoirs compatible with the objective ** to enhance recreation on minor tributaries.
Fishing	Meet projected needs at single-purpose projects economically justified; include in multi-purpose projects where justified, including downstream fishing benefits for flow augmentation.	Meet projected needs including both user and expansion benefits. Select measures close to growth centers, major highways, etc., to attract expansion effects.	Meet projected needs by stream enhancement and reservoirs compatible with the objective; use compatible ** upstream reservoirs to enhance stream fishing during low flow periods.
Coal Mine Drainage Pollution	Include abatement measures up to level of estimated tangible user benefits.	Include watersheds for abatement with benefit-cost ratio of 0.1 to 1.0 or greater within individual watershed.	Complete abatement for all problem watersheds; removal of scenic scars due to mining operations.

TABLE 5 (CONT'D)

Category of Requirement	Economic Efficiency	Regional Development	Environmental Quality
Flood Damage Reduction	Include measures most economically efficient as part of a system to meet water resource needs. Flood plain management included as complementary program.	Provide local flood protection and storage to benefit-cost ratio not less than 0.7. Flood plain management included as supplementary program.	Only include storage in reservoirs compatible with the objectives **; rely primarily on flood plain management and local flood protection not aesthetically detractive.
Land Treatment	20% acceleration of present program plus complete treatment of critical areas.	20% of acceleration of present program plus complete treatment of critical areas.	20% of acceleration of present program plus complete treatment of critical areas.
Streambank Stabilization	Provide measures economically justified by primary benefits.	Provide measures justified by primary and secondary benefits; favor growth centers.	Provide only where needed protection would be aesthetically beneficial.
Hydroelectric Power	Provide capacity to point of maximum net benefits as part of a multi-purpose system to meet water resource needs.	Provide capacity to point of maximum net regional (total) benefits as part of a multi-purpose system to meet needs.	Provide power generation when feasible at reservoir sites compatible with objective **; limit to extent not damaging to reservoir values.

** "Compatible" reservoirs are those that: Cause no loss of unique ecological values; do not conflict with "wild" or "scenic" rivers; do not result in net loss to high value fishery; add to scenic quality of project area; and cause relatively small loss of social, cultural, or agricultural values.

CHAPTER VI - SCREENING ALTERNATIVES AND PREPARING A BASE PLAN

A. FORMULATION PROCEDURE

The Plan Formulation Workshop began work on a base plan during December of 1966 with the data then available on resource supply, demand, and alternative solutions to the problems. Even though some essential information was yet incomplete, such as the work on coal mine drainage pollution, it was agreed that formulation must proceed through Phase II, the process of "screening out" of impracticable alternatives for the base plan.

The objective for the base plan during the early months of formulation was economic efficiency, the combination of alternatives apparently the most economically efficient to meet water-related resource needs through the year 2020. (The consideration of alternatives specifically responsive to the regional development and the environmental quality objectives had not yet been introduced to the Workshop participants.)

It was pointed out during the first days of screening of alternatives that any measures retained after the first look would not necessarily remain after further refinement. Conversely, an alternative not prominent in early discussion, but not excluded for reasons of obvious impracticability may appear, after further study, to be the best available.

The procedures used during the screening (Phase II) meetings of the Plan Formulation Workshop consisted of the following broad steps:

1. An examination of the gross water resource requirements.

2. A determination of net requirements, in excess of the existing development and dependable supply (deficit or need).

3. A review of alternative means of satisfying deficits.

4. An identification of alternatives for further study, and the elimination of clearly impracticable alternatives from further consideration.

An early set of "needs" tables (similar to Attachment 1) were used to evaluate steps 1 and 2. These tables were used to estimate the size and location of the deficiencies for water supply, water quality, and irrigation based on surface supply. They also included an estimate of the average annual flood damages, the recreational needs, the fishing needs, land areas requiring treatment, and the location of bank erosion and mine drainage pollution problem areas. (The "needs"

tables were used throughout the plan formulation process with continual updating as new data were developed or submitted.)

Step 3 was a review of the alternative measures listed in Table 6 for each point where a deficiency was located.

Step 4 called for distinguishing between alternatives that would be clearly impracticable and those that warranted further investigation. A summary of the screening process for each of the various water-related needs categories follows Table 6, the list of potential solutions examined.

B. ALTERNATIVE SOLUTIONS

Early in the Study, a wide range of possible solutions to water and related land resource problems were identified for evaluation. Studies of the potential of each solution to fit into a plan for the Basin were aimed at engineering and management feasibility and cost (economic feasibility). The depth of investigation for a specific alternative varied greatly, however, depending on the degree of sophistication required to make a reasonable decision on its practicability, as well as on the extent of information already available. In a few cases (weather modification, for instance), the state of the art has not progressed to a point where an equivalent comparison can be made with other solutions. When such a case arises, the judgment of the planning professional must weigh much more heavily in its handling.

The following list (Table 6) includes all of the potential kinds of solutions to resource problems that were examined during the Susquehanna River Basin Study. This list does not imply equal depth of penetration by the participating agency assigned the data preparation task, nor does the order of presentation indicate any priority or preference. Information on many of the structural measures listed is summarized in Appendix K (1). Other measures are described in the appropriate appendix volumes.

The plan formulation procedure would be similar to that used

TABLE 6

POTENTIAL SOLUTIONS TO
WATER RESOURCE REQUIREMENTS

Water Supply (Municipal, Industrial, and Agricultural)

- Surface storage (including streamflow augmentation)
- Improved quality of source
- Ground water development (including aquifer recharge)
- Pipeline diversion
- Waste water reclamation and reuse
- Saline or brackish water conversion
- Weather modification
- Reduced water use by:
    - metering and pricing
    - development control
    - rationing
    - public education
    - facilities repair or replacement

General Outdoor Recreation (Water-Oriented)

- Improvement of existing water areas by:
    - low flow augmentation (quantity)
    - improved water quality (all measures)
    - improved access and facilities
    - stream channel improvement
    - enhancement of natural environment
- Development of new water areas by:
    - reservoir storage (including small ponds)
    - low in-channel dams
    - access and facilities at new areas
    - enhancement of natural environment

Fish and Water-Associated Wildlife Enhancement

- Improvement of existing water-associated habitat by:
    - low flow augmentation (quantity)
    - improved water quality (all measures)
    - stream channel improvement
    - enhancement of adjacent land habitat (including wetlands)
    - fish ladders and fishways at obstructions
- Development of new water habitat by:
    - reservoir storage (including small ponds)
    - sub-impoundments at major reservoirs
    - enhancement of adjacent land habitat (including wetlands)

The three response systems for the

TABLE 6 (Cont.)

Water Quality Maintenance (Non-Acid)*

- Advanced waste treatment processes
- Streamflow augmentation from:
  - surface storage
  - ground water
- Pipeline relocation of effluent discharge point
- Mechanical reaeration of streamflow
- Reduced waste loading by:
  - reduced domestic use (see Water Supply)
  - industrial process modification
- Sediment control (see Erosion and Sediment Control)

Water Quality Restoration (Coal Mine Drainage)

- Surface mine reclamation (including diversion of inflow)
- Sub-surface mine sealing (including diversion of inflow)
- Chemical neutralization of drainage:
  - collection and treatment
  - in-stream treatment
- Streamflow augmentation for:
  - acid neutralization (alkaline releases)
  - acid and mineral dilution

Flood Damage Reduction

- Reservoir storage
- Levees and floodwalls
- Channel improvement
- Floodwater diversion
- Flood proofing
- Permanent relocation
- Flood warning and temporary evacuation
- Flood insurance
- Redevelopment
- Flood plain zoning (restricted use or filling)
- Weather modification
- Watershed land treatment

Erosion and Sediment Control

- Conversion of land use (including reforestation)
- Improved practices for existing uses (land treatment)
- Sediment control structures (including reservoirs)
- Stream and reservoir bank stabilization

*Assuming adequate (secondary) treatment at source of all municipal and industrial wastes.

TABLE 6 (Cont.)

Hydroelectric Power

Run-of-river generation
Reservoir storage (including reregulation)
Pumped storage

C. SCREENING OF ALTERNATIVES

Water Supply (Municipal, Industrial, and Agricultural)

The Workshop agreed that they would evaluate in detail the potential of surface storage, ground water development including aquifer recharge, and within-basin diversions, wherever applicable. They agreed that diversions of water into the Basin were not feasible, since no projected water shortage location in the Basin was noted adjacent to a relatively "water-rich" neighboring drainage. (Most basins neighboring on the Susquehanna already have experienced more serious water shortages.) Those out-of-basin diversions already authorized were assumed at that time as committed resources.

Improvement of the quality of a potential water source, not now used due to poor quality, appeared to be feasible in a number of cases and was retained as a viable alternative. Conversion processes in use for brackish or saline waters could be adapted to potential sources contaminated by coal mine drainage (acid and undesirable minerals in solution). However, the Workshop agreed, after considerable discussion and examination of potential applications, that saline or brackish water conversion itself, did not appear to be an economically competitive or practicable alternative anywhere within the Basin. Either the nearest source of brackish water (Chesapeake Bay) was many miles more distant than an ample supply of fresh water, or in a few isolated cases it was available as ground water below yet undeveloped ground sources of suitable quality. In addition, brine disposal could be a potential pollution problem at the conversion plant site. Brackish conversion, however, might become a potential alternative for the distant future for the Baltimore metropolitan area (not in the Basin, but within the Basin's water supply service area).

Reclamation and reuse of waste waters, assumed to some extent in the projection of the industrial component of water supply demands, became a different problem for municipal water supply. Particularly in the Susquehanna Basin, where water crises have been relatively few compared to the rest of the northeastern United States, the general public does not appear to be ready at present to accept essentially direct recycling of wastes, even though some are now "reusing" water

from upstream communities. Discounting public acceptance as a factor beyond the early action period (after 1980) reclamation and reuse could become viable when compared economically with other development alternatives. The Workshop discarded the alternative for early action except for possible agricultural use (irrigation), and reserved judgment for late action.

Weather modification was recognized as a highly questionable alternative of indeterminate value for increasing water supply--particularly during the early action period. Subsequent review eliminated it as a practicable water supply alternative for the Susquehanna, since neither the costs nor the knowledge of effects--both good and bad--approach acceptable reliability.

Reduced water use, with its five listed sub-alternatives for water supply, were also discussed at some length by the Workshop participants. Subsequent reviews of available information resulted in the following conclusions:

a. Metering water use and pricing water at the cost to produce and deliver it, where not already practiced, show no evidence of significantly changing the average water demands of the designated service areas, as projected. While this alternative would remain available to communities as a policy, particularly during short peak-use periods, the Workshop was still obligated to identify additional supply alternatives and their cost, at least up to the limit of the year 2020 deficit.

b. Development control is an alternative solution to prevent demand exceeding supply, particularly at locations where development cost would be relatively expensive or potentially disruptive. The obligation again remains to place it in perspective against alternative choices that would not constrain normal economic growth through 2020.

c. Rationing is a form of development control during sub-normal water supply availability. It could be effective in reducing peak daily uses (summer lawn watering, for instance) not reflected in the water supply projection of demand, and in preventing inordinately large irrigation withdrawals. Rationing is one of the assumed alternatives when the supply, developed or not, drops during droughts below the failure criterion selected (See Table 5 in Chapter V).

d. It did not appear that public education to reduce water use would affect significantly the water supply demands, as projected. However, it would be a necessity to make rationing,

development controls, reuse, and special pricing policies acceptable to the using public and industries. It also might contribute to acceptance of more frequent "failures" of the supply, contrary to the present trend of thought for public utilities.

e. Repair or replacement of inadequate or outdated facilities could reduce the loss of water in municipal systems due to leakage, possibly reducing total demand. Assuming that future new facilities and replacements would be properly constructed and maintained, no significant long term reduction in demand could be reasonably assumed by the Workshop participants.

General Outdoor Recreation (Water-oriented)

All of the alternatives listed in Table 6 for water-oriented recreation were retained for further consideration. However, generalized assumptions had to be made concerning the potential level of recreational use of the existing water areas, particularly streams to be protected and managed for recreational purposes. This was necessary since the scope of study did not include identification of individual parcels of land for development of facilities adjacent to the streams. The Workshop also considered the generalized recreational potential of each individual reservoir site as part of the screening process.

Fish and Wildlife Enhancement

The Workshop did not directly eliminate any of the alternatives listed to improve existing habitat or to develop new habitat. Most emphasis would be placed on those measures that would upgrade stream quality, particularly where now degraded by acid pollution, and those that would protect high quality stream reaches. Small impoundments would be given close attention to develop new fishing opportunity where lacking near communities or where poorly distributed. The value of stream channel improvements (clearing islands or constructing gabions) was considered to be primarily a local detail beyond the scope of a broad, comprehensive study such as the Susquehanna.

The question of fish ladders or fishways at obstructions was a subject of extended discussion. The several hydroelectric power dams on the lower Main Stem (see Figure 1 in Chapter II) were of principal concern as barriers to anadromous fish passage. Since specific detailed studies were already underway to determine the feasibility of fish passage on the lower Main Stem, this item was left unresolved and retained for later review as better information became available.

Water Quality Maintenance (Non-acid)

Consistent with the implementation plans of the several States to meet their water quality standards, the Plan Formulation Workshop assumed that secondary treatment facilities would be provided at all waste service areas during the early action period, except for those communities discharging to streams that would remain acid beyond 1980. Most of these facilities are planned for completion, or will have construction funds definitely committed, by 1972 or soon thereafter. At those locations where the expected waste loading with the equivalent of secondary treatment will degrade stream water quality below the assumed criteria, the alternatives of advanced waste treatment, streamflow augmentation from surface and ground storage, and pipeline relocation of the effluent were identified for further detailed study. Since these alternatives are not directly comparable as they affect other water resource requirements*, each must be investigated in a larger systems context.

Mechanical reaeration of streamflow to increase oxidation of residual wastes from treated effluents was discussed and discarded for all applications except those river reaches where the water is relatively deep and slow moving. The lower main stem of the Susquehanna, in the pool formed by the Safe Harbor hydroelectric power dam, would be such a location.

Reduced waste loading by limiting domestic water use was considered by the Workshop and discarded for lack of information, indicating that the projected average waste loadings would not be significant or realistically reduced. Some of the management measures for reducing water use, listed under water supply, might reduce the total volume of waste flows, but would have proportionately less effect on the wastes themselves. The effect would very likely be a small increase in the concentration of wastes that enter the sewer system and a correspondingly small decrease in the total volume to process. Reduced waste loading by industrial process modification was considered in developing realistic estimates of future industrial wastes; those industries showing the potential for a downward trend in water use and waste loadings were evaluated accordingly. Industrial process modification, beyond the level assumed in developing the individual estimates for each service area, could not be considered further by the Workshop for lack of a definite base for predicting such adjustments.

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*Low flow augmentation also can provide benefits during drought conditions for water supply, recreation, fish and wildlife, and for protection of the Chesapeake Bay's ecological balance.

Sediment was treated specifically as a pollutant apart from municipal and industrial sources. Its damage to water quality goes beyond the suspended and deposited sediments in flowing waters to include the nutrients and pesticide contaminants frequently carried (adsorbed) with them. Sediment control measures for water quality enhancement were considered a part of a land treatment program for erosion and sediment control.

Water Quality Restoration (Coal Mine Drainage)

Abatement of pollution from coal mine drainage included study of surface mine reclamation, sub-surface mine sealing, and chemical neutralization methods. Particular emphasis was given to collection and treatment of acid drainage, at least as a basis for estimating costs of abatement, since this appears at present to be the most reliable general method of controlling the problem. Steamflow augmentation, either to neutralize or dilute the acid content of coal mine drainage, was discussed by the Workshop as well as the Mine Drainage Work Group*. No specific augmentation storage site could be identified for further study for the primary purpose of abating mine acid pollution with the extent of data available.

Flood Damage Reduction

All of the flood damage reduction alternatives listed in Table 6 were discussed in the screening process. The conventional, reliable, and widely used measures of reservoir storage, levees and floodwalls, and channel improvement would be considered further where the flood damage potential warranted. Although not discarded entirely as an alternative, diversion of floodwaters did not appear to be suitable to the topographic conditions in the Susquehanna Basin.

Over the past 30 years, a substantial investment had already been committed by the Federal and State Governments to avoid and prevent flood losses (see Chapter II). For purposes of the base plan and the economic efficiency outlook, extensive structural investment in further flood control measures would be unlikely to be economically feasible. To offer the most effective solution to the problem, the Workshop agreed to give specific attention to flood proofing, relocation, redevelopment, warning and evacuation, flood plain zoning, and flood insurance as complementary measures to avoid future flood losses. Flood insurance was recognized as a means of reducing the financial impact of flood losses rather than preventing the loss itself.

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*A subdivision of the Water Subcommittee of the Coordinating Committee. See Appendix A for organization and structure of Subcommittees.

Information then available on the efficacy of weather modification was reviewed and the alternative possibility discarded. The present extent of research and knowledge, especially to reduce flooding, is far too meager and unreliable to permit further consideration at this time. Additional investigation would be far beyond the scope of this comprehensive study. Watershed land treatment and management to reduce flood losses was recognized as an important part of the comprehensive plan, particularly for its values to rural areas, even though the impact on widespread or intense storms would be minimal in reducing flood stages downstream.

Erosion and Sediment Control

Watershed land treatment and management practices also benefit both rural and downstream areas by reducing the quantity of sediment and adsorbed nutrients and pesticides reaching the streams. The Workshop agreed to develop a program for each sub-basin, considering all the erosion and sediment control measures listed in Table 6.

Hydroelectric Power

The Workshop agreed to consider the listed alternatives for hydroelectric power production--reservoir storage, pumped storage, and run-of-river generation--as part of base plan formulation. They also agreed to accept the Power Subcommittee's following recommendations as a guide to hydropower consideration:

a. Identify development to meet other water resource requirements, then consider the economic and financial feasibility of including hydroelectric power development in suitable projects.

b. Avoid, if possible, selecting projects that would preclude developing the high priority power projects of the electric utilities.

c. Locate water resource developments, where possible, to complement the high priority power projects.

D. SELECTION OF BASE PLAN MEASURES

The Plan Formulation Workshop, after completing the screening of alternatives, spent several months in advancing the level of information on specific alternatives and their potential to solve the identified water resource problems. The Workshop participants also realized in preparing their information that formulation of a base

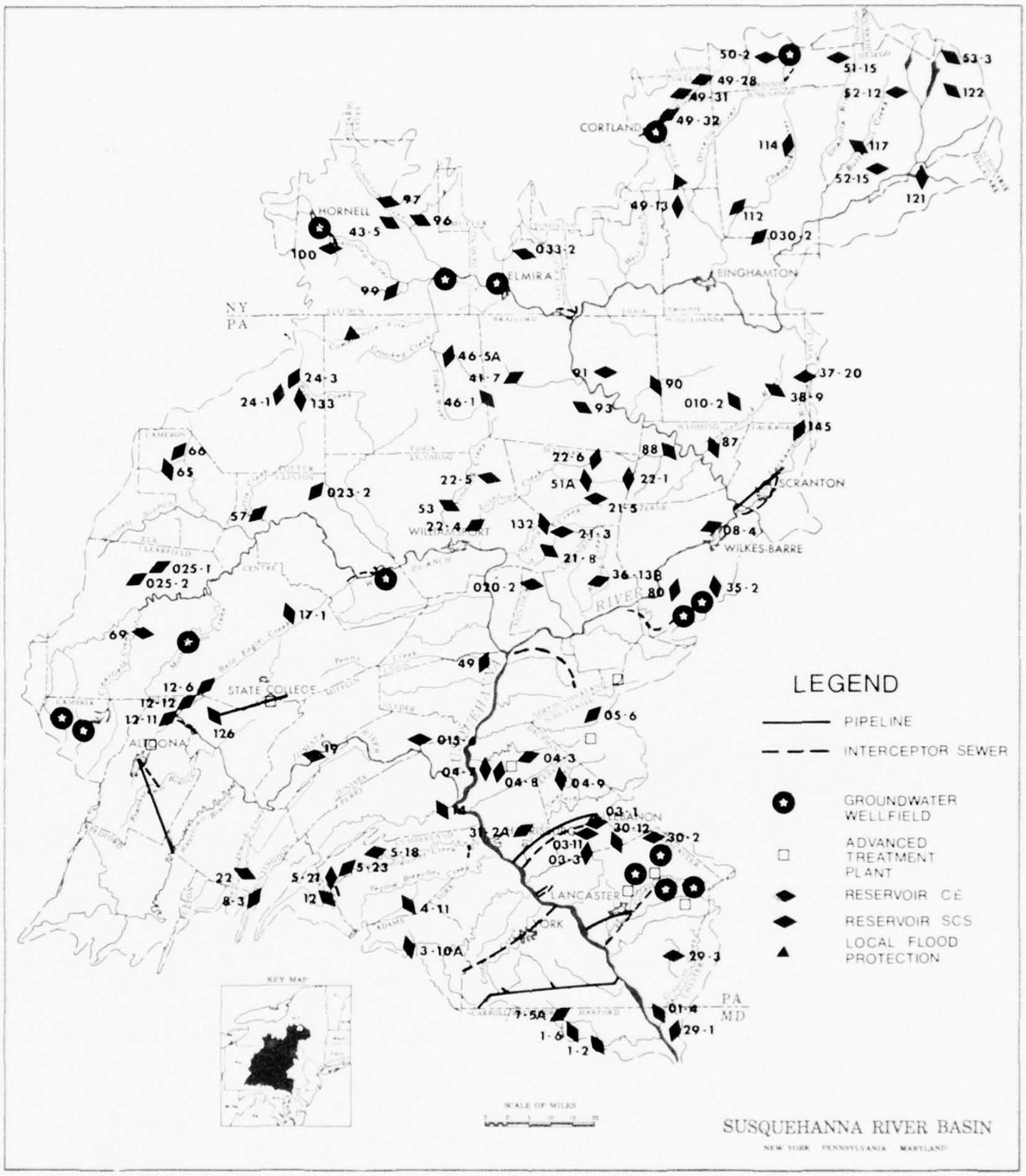
plan would be only the beginning of the process of plan assembly; more and better information was needed, as well as improved arrangement of existing information.

In May of 1967, The Workshop resumed work on a preliminary or "first-cut" base plan for the year 2020, using the best available information on requirements and alternative solutions. Each sub-basin was considered separately, in turn, beginning with the headwater areas and working downstream. Water resource problems were isolated, compared in schematic arrangement by sub-basin with the alternatives available, and the apparent most economical solutions were selected according to the base plan (economic efficiency) criteria. (The interest rate used at this time was 3-1/8 percent.)

Selections for the preliminary base plan were founded primarily on cost-ranking of alternatives and on the professional judgment of the Workshop members in applying the base plan criteria. No program selection could yet be made for abatement of the mine drainage pollution problem, for flood plain management, and for land treatment, since the pertinent data on costs and benefits were still being prepared. The first round of base plan formulation, however, provided a preliminary system of measures that was still incomplete for a number of locations and for several water resource problems. The task of evaluating alternatives had been greatly reduced, and the areas of omission pinpointed.

The next Workshop meeting in August concluded work on a base plan. Since May the preliminary base plan had been revised based on improved data on needs, benefits, and costs. A basic criterion used in this revision was to improve selection of the apparent optimum system of meeting 1980 and 2020 needs at each location, with exceptions where judgment appeared to warrant a more costly alternative. The key parameters used to review the least costly reservoir alternatives were the relative costs per cubic feet per second of added flow for water supply and water quality, cost per surface acre for recreation and fishing, and cost per acre-foot of storage for flood control. A simplified set of the screening, or relative ranking, tables developed to assist in comparing the reservoir projects is included in Chapter XI as Attachment 2.

The base plan covered the entire Susquehanna Basin, except for the Altoona and the Wilkes-Barre areas, where incomplete data prevented agreement on a plan at that time. Also no specific plan addition was made for water supply for the Baltimore Metropolitan area; the low flow of the Susquehanna River at the Conowingo intake then appeared to meet the projected water demand in 2020. The base plan, however, did not yet include specific programs for land treatment, for coal mine drainage abatement, or for flood plain management, because adequate data were still in the process of being developed. The project selections of the Plan Formulation Workshop through 2020 are indicated on the Plan Formulation Summary Tables (Attachment 3 in Chapter XI) and on Figure 4.



BASE PLAN PROJECT SELECTION (YEAR 2020) Figure 4

As it had developed, the process of formulating a base plan: (1) illustrated weaknesses in the data available, or that which could be developed, for a number of non-structural and management measures; (2) pinpointed where data were yet inadequate to make valid decisions on the best alternatives; (3) highlighted the most promising of conventional alternatives, especially reservoirs, so that necessary project formulation and data refinement could be accomplished; and (4) indicated areas where the needs would be most difficult to meet with available alternatives.

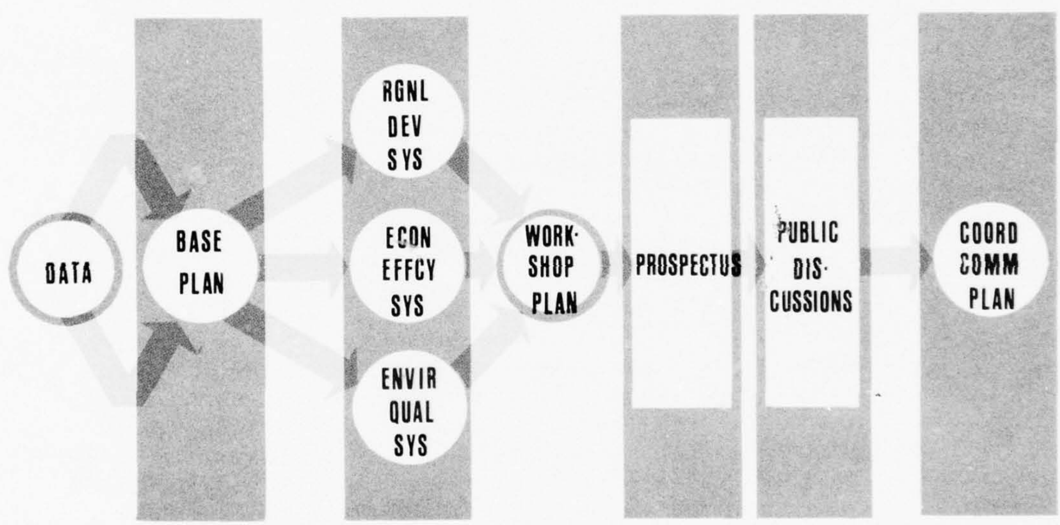
However, a significant achievement of base plan formulation, apart from focusing on the data limitations, was the assembly of a diverse group of individual water and related land resource professionals representing differing disciplines and agency interest. This group first had to develop a degree of mutual understanding and consideration of the role of each participant and of his potential contribution. A common base of understanding of terminology and viewpoint was an essential first step to be able to work effectively within the Workshop. Formulation of the base plan provided the "training field" to make multiple-objective planning, as much as possible, a coordinated, multi-disciplined effort.

E. MODIFICATION OF THE PLANNING APPROACH

Besides concluding work on the base plan, the August 1967 Workshop session was important for an additional reason. The members agreed at this point to accept a suggested modification in the procedure (Figure 3 at the end of Chapter IV) that would lead to the adoption of a Coordinating Committee Plan. The base plan would represent a distinct step in formulating the three separate response systems to meet the objectives of economic efficiency, regional development, and environmental quality, respectively. The separation of the base plan from the economic efficiency response system was in recognition that the base plan, as formulated, represented a departure from the intended response to the economic efficiency objective. Several Workshop parcipants, not sure that the Coordinating Committee would approve the approach presented early in 1967 by the Workshop chairman, were reluctant to agree to include a number of apparently "efficient" measures in the base plan due to considerations other than economic efficiency. On the other hand decisions which had been made earlier based on apparent least cost were subject to change as data improved. The easier path at this point was to recognize the base plan as a vehicle to prepare the Workshop--participants and the basic data--for the task of formulating response systems for each planning objective.

After the three response systems were forwarded, they would be reviewed and commented on by the Coordinating Committee before a Workshop Plan would be synthesized. The Workshop Plan, after adoption by the Coordinating Committee, would become the Committee's tentative plan

to be presented to the public as the Susquehanna Prospectus, as it was later designated. The Prospectus would require modification, hopefully minor, prior to being adopted as the Coordinating Committee Plan that would appear in the final Study report. The modified planning approach is illustrated in Figure 5.



PLANNING APPROACH—SEPTEMBER 1967 Figure 5

CHAPTER VII - PREPARING ALTERNATIVE SYSTEMS BY OBJECTIVE

A. THE FORMULATION APPROACH

At the September 1967 meeting, the Coordinating Committee reviewed the selections in the base plan and the suggested multiple-objective approach to formulating the Coordinating Committee Plan. (See Figure 5 at the end of Chapter VI.) Extensive discussion followed on the necessity to formulate three separate response systems and opposed to going ahead directly with formulation of the Workshop Plan.* The Coordinating Committee, as a compromise, requested the Workshop to prepare response systems for the year 2020 for each of the three objectives of economic efficiency, regional development, and environmental quality for a "test area" that included all of Sub-basins I, II, and III.

In March 1968, the Workshop began the multiple-objective formulation task, beginning with the "test area." The criteria for each system (See Table 5 in Chapter V for a summary) were discussed and agreements reached on their use.

The Workshop also agreed that primary emphasis would be given to evaluating costs and benefits, to the extent practicable, for the economic efficiency and the regional development response systems. The environmental quality response system, however, would be based on criteria other than benefit-cost analysis as the primary basis of selection. The Workshop members recognized the difficulty of estimating expansion benefits as part of the job of formulating a regional development system; they also knew they would have to use their informed judgment to the greatest extent for the environmental quality system.

The Workshop participants were reminded that all of the measures which had been considered during base plan formulation would be again available for inclusion in one or more of the three response systems. Only those measures that were eliminated during the screening process for reasons of impracticability would not be again considered: weather modification and desalinization, for instance.

Due to the large number of structural alternatives, especially reservoirs with over 900 sites in the several inventories available, it was agreed to hold several limited meetings to review the ranking tables (Attachment 2) and to make preliminary selections in the test sub-basins for each of the three response systems. Following the preliminary selections, the full Workshop would meet to refine the preliminary selections.

*This was discussed at each meeting of the Coordinating Committee since it was first proposed in February 1967. The multiple-objective approach was made public at the open Coordinating Committee meeting in May 1967 at Williamsport, Pennsylvania.

The plan formulation procedure would be similar to that used for the base plan. Each sub-basin would be examined in turn, moving from the headwater areas in a downstream direction. All work in response to a single objective would be completed (for the three sub-basins) before moving to the next objective.

The same basic pattern of water resource requirements, as they had been revised through the year 2020, would be used in formulating each response system. This simplification was recognized as not being representative of variations in growth if different basinwide objectives were in force, but the emphasis here was intended to be on the response of alternatives to different objectives, with a minimum of unnecessary complexity. The Workshop members would attempt to meet all water resource requirements and problems to the extent that the criteria permitted or implied.

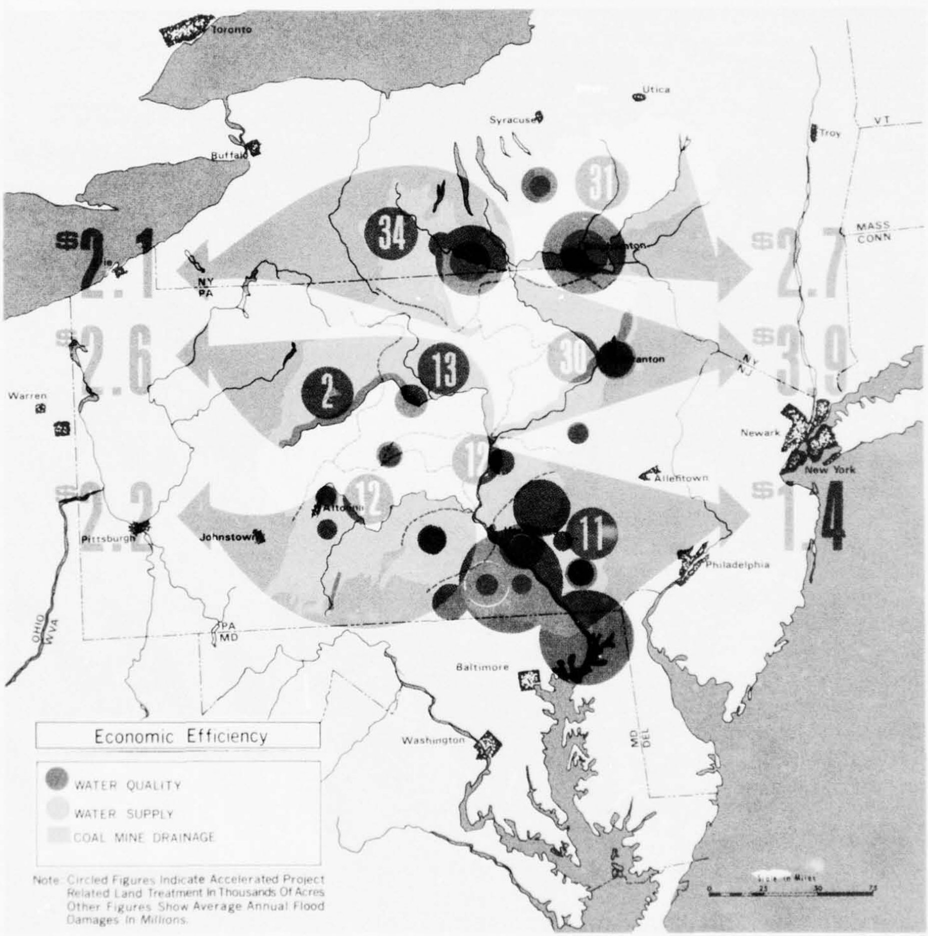


Figure 6

The three response systems for the upstream "test area" were assembled and reviewed by the full Workshop by the end of April 1968 and presented to the Coordinating Committee at their May meeting. The concensus of the Committee members, following their review of the selections for each objective and discussion of the procedure, was to continue the three-objective test through the remainder of the Basin, completing each response system to the extent that the tight schedule permitted.

Following the May Coordinating Committee meeting, the Workshop carried the multiple-objective formulation effort through the remainder of the Basin, drawing heavily on the combined information and experience built up in the Workshop since the group was first assembled nearly 2 years before. By mid-June 1968, the task of formulating a "first-cut" response system for each of the three objectives for the Basin was completed.

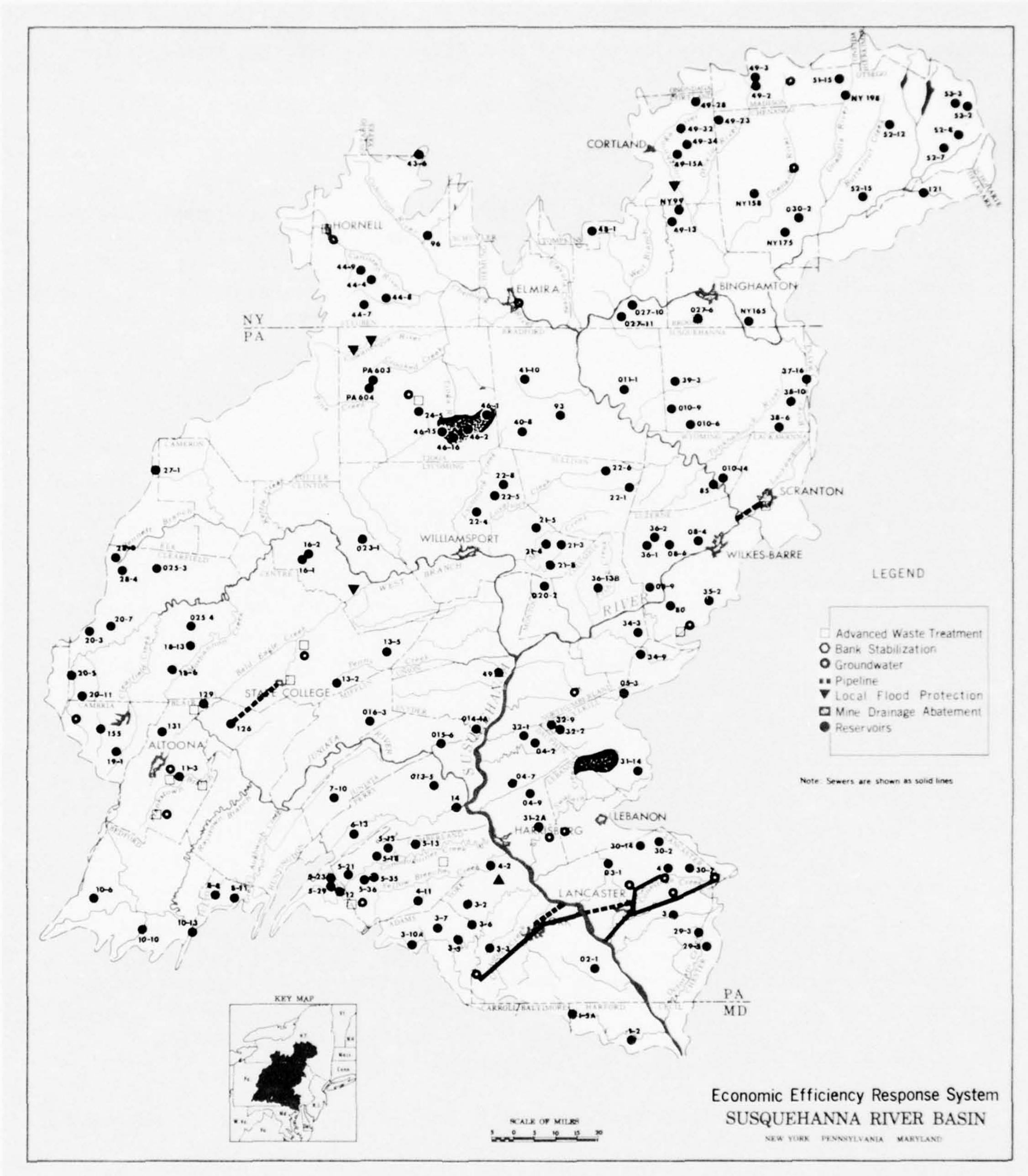
B. THE ECONOMIC EFFICIENCY RESPONSE SYSTEM

The economic efficiency system was formulated to meet the identified water resource requirements to the extent that each measure would be economically justified by national income benefits (primary or user benefits) equal to or greater than the cost. Selections were based on the most up-to-date cost and benefit data developed for the Study, supplemented by the judgment of the Workshop members. The requirements for development, as tabulated in Attachment 1, were arranged on schematic worksheets by sub-basin. The task became one of searching the alternatives for the system that appeared to yield the maximum of net national income benefits. Figure 6 is a graphical representation of the key resource requirements (needs) for the entire Basin that were stressed for the economic efficiency response system. Figure 7 represents the structural selections for this system as indicated by the legend shown on the figure. (See also Attachement 3, Chapter XI, for a list of project selections.)

C. THE REGIONAL DEVELOPMENT RESPONSE SYSTEM

The regional development system would provide for meeting the identified water resource requirements to the extent that each measure is economically justified by combined regional and national income benefits (expansion and use benefits). This system also would reflect to the greatest degree of the three systems the interests of the individual States for their respective regions.

Selections for this system were based on the same water resource requirements indicated in Figure 6, but alternative solutions were evaluated in terms of net regional and national income benefits based on the best information available to the Workshop. One general result, as expected, was the inclusion of a larger number of project selections (greater investment) in this system.



LEGEND
Advanced Waste Treatment
Bank Stabilization
Groundwater
Pipeline
Local Flood Protection
Mine Drainage Abatement
Reservoirs
Note: Sewers are shown as solid lines
Economic Efficiency Response System
SUSQUEHANNA RIVER BASIN
NEW YORK PENNSYLVANIA MARYLAND
SCALE OF MILES
KEY MAP
CORTLAND
HORNELL
ELMIRA
BINGHAMTON
SCRANTON
WILKES-BARRE
WILLIAMSPORT
STATE COLLEGE
ALTOONA
LEBANON
LANCASTER
NY
PA
MD

Figure 7

The judgment of the members was called upon to a greater degree than for the economic efficiency system due to the serious difficulties in evaluating expansion benefits adequately, and to the regional development potential of alternate selections to stimulate economic activity when related to a growth center. Figure 8 shows the location of the most likely centers of potential growth. These centers were identified for the Basin as focal points for the selection of expansion-inducing alternatives. Figure 9 shows the project selections for the regional development system, as does Attachment 3.

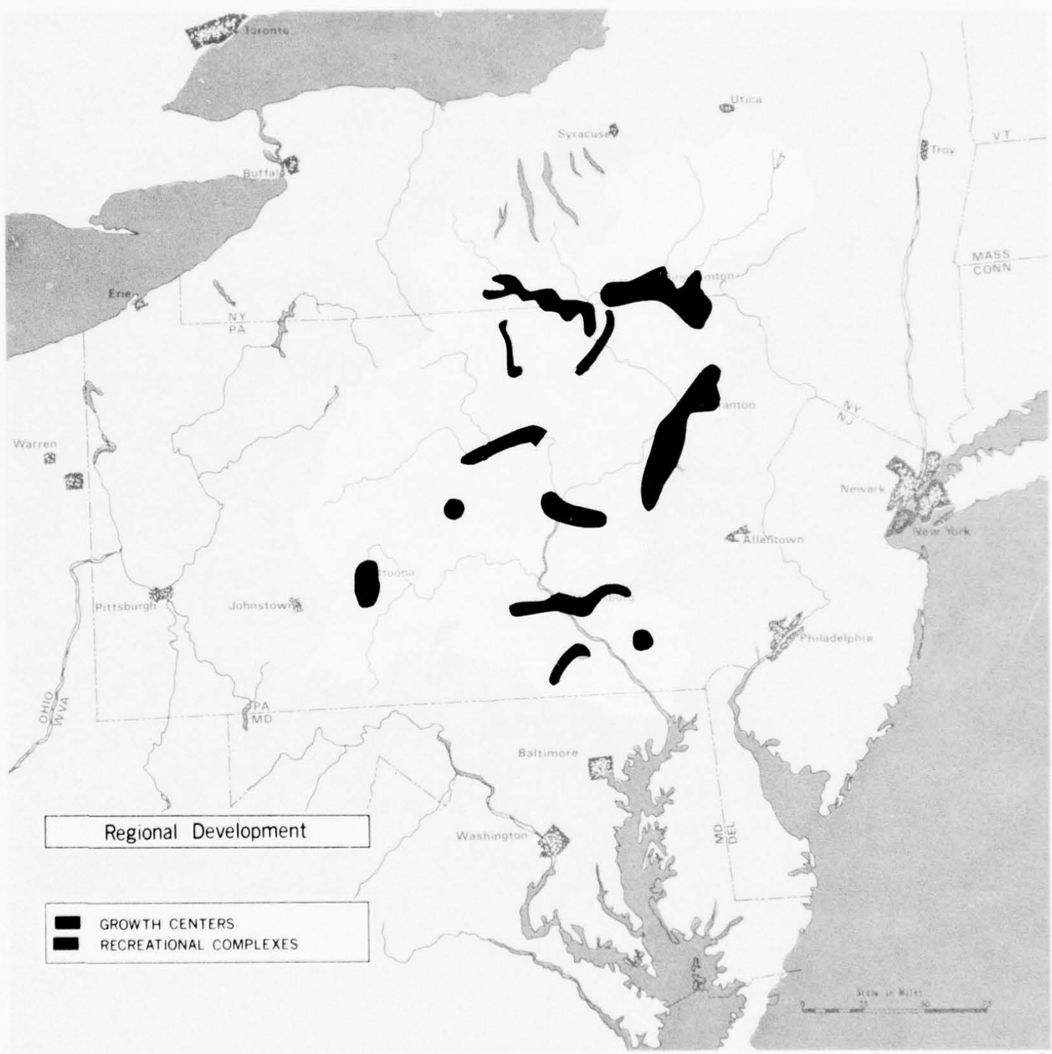


Figure 8

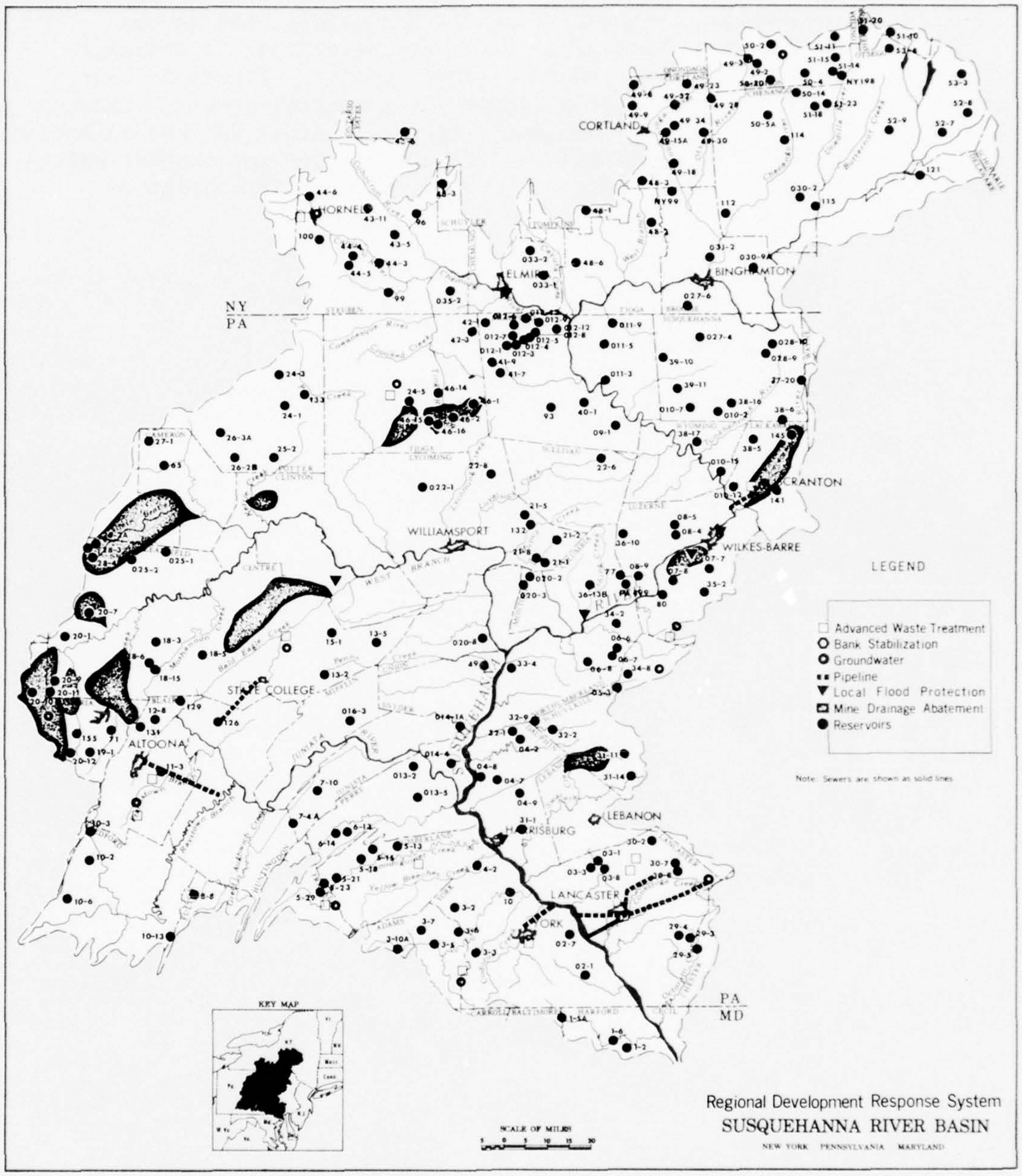

LEGEND
Advanced Waste Treatment
Bank Stabilization
Groundwater
Pipeline
Local Flood Protection
Mine Drainage Abatement
Reservoirs
Note: Sewers are shown as solid lines
Regional Development Response System
SUSQUEHANNA RIVER BASIN
NEW YORK PENNSYLVANIA MARYLAND
KEY MAP
SCALE OF MILES
CORTLAND
BINGHAMTON
HORNELL
ELMIRA
SCRANTON
WILKES-BARRE
WILLIAMSPORT
STATE COLLEGE
ALTOONA
HARRISBURG
LEBANON
LANCASTER
YORK
NY
PA
PA
MD

Figure 9

D. THE ENVIRONMENTAL QUALITY RESPONSE SYSTEM

The environmental quality system would provide for meeting the identified water resource requirements (Figure 6) to the extent that each measure selected would enhance and preserve, or at least not adversely affect, the general quality of the natural environment. The emphasis for this system is on the water-related environmental factors that are often subjugated when "efficiency" objectives dominate.

Selection of measures for the environmental quality system would be based less on benefit-cost analysis and more strongly on the knowledge and information of the Workshop members in areas related to the environmental sciences. To expand and reinforce their judgment, a number of special studies for the Basin were used.

One of these studies 1/ inventoried the visual landscapes of the Susquehanna Basin, evaluated these landscapes on the basis of selected visual elements, and considered the impact of water upon these evaluations. The visual impact of land and water was rated for many of the major reservoir sites in the inventory. The quality of the shoreline configuration and the contribution of the reservoir to the land pattern were two of the visual parameters considered in classifying sites as having high, medium, or low configuration qualities.

A second special study 2/ described the valuable archeological resources throughout the Basin. The potential major reservoir sites in the inventory were listed as either "recommended" or "not recommended" based solely on their archeological impact. A report on the history 3/ of the Susquehanna Basin also contained pertinent information about the location of the key historical sites in the Basin, many of which are near the major rivers.

The results of such studies, as well as the special Federal and State agency studies on water quality, recreation, fish and wildlife, and coal mining impacts, contributed to a compilation of critical areas of concern for the Workshop members. Figure 10 shows some of the more important environmental values superimposed on a map of the Basin, including important fishing streams, historical sites of value, special archeological sites, and an area of concern for cultural preservation (Pennsylvania Dutch Country), as well as the areas scarred by strip mining and culm piles. Figure 11 shows the environmental quality system project selections. (Also see Attachment 3.)

E. MULTIPLE-OBJECTIVE FORMULATION RESULTS

At the end of the multiple-objective formulation stage, the three systems were considerably short of refinement to the extent that they could be called "comprehensive plans." The regional development and the environmental quality systems were the product

of one cycle of formulation. The economic efficiency system benefitted to a great extent from the base plan effort, but still was the product of only one full cycle of formulation, using data one step beyond that of the preliminary stages during base plan work.

The three systems also had not been fully detailed for different streamside recreation and flood plain management programs, and land treatment showed no significant variation among the three systems. The development of adequate cost and effect data to show a range of application of such programs was especially difficult, often involving details beyond the study scope or the data availability from other sources. A differing role in each plan was recognized, however, as shown by the summary table below indicating high, moderate, or low impact for the streamside recreation and the flood plain management programs.

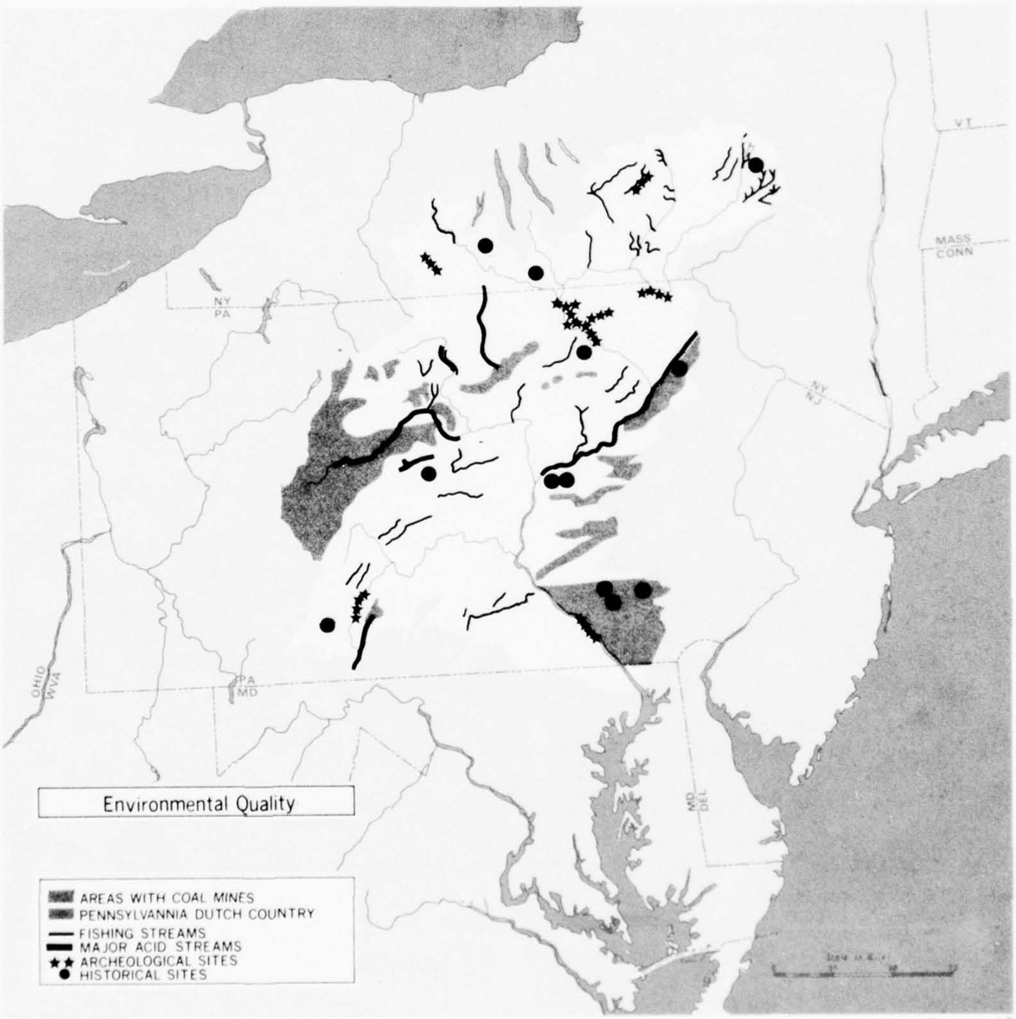


Figure 10

TABLE 7

SUMMARY OF MANAGEMENT PROGRAM IMPACT

	Economic Efficiency	Regional Development	Environmental Quality
Streamside Recreation	Low	Moderate	High
Flood Plain Management	Low*	Low	High

*Moderate in some areas

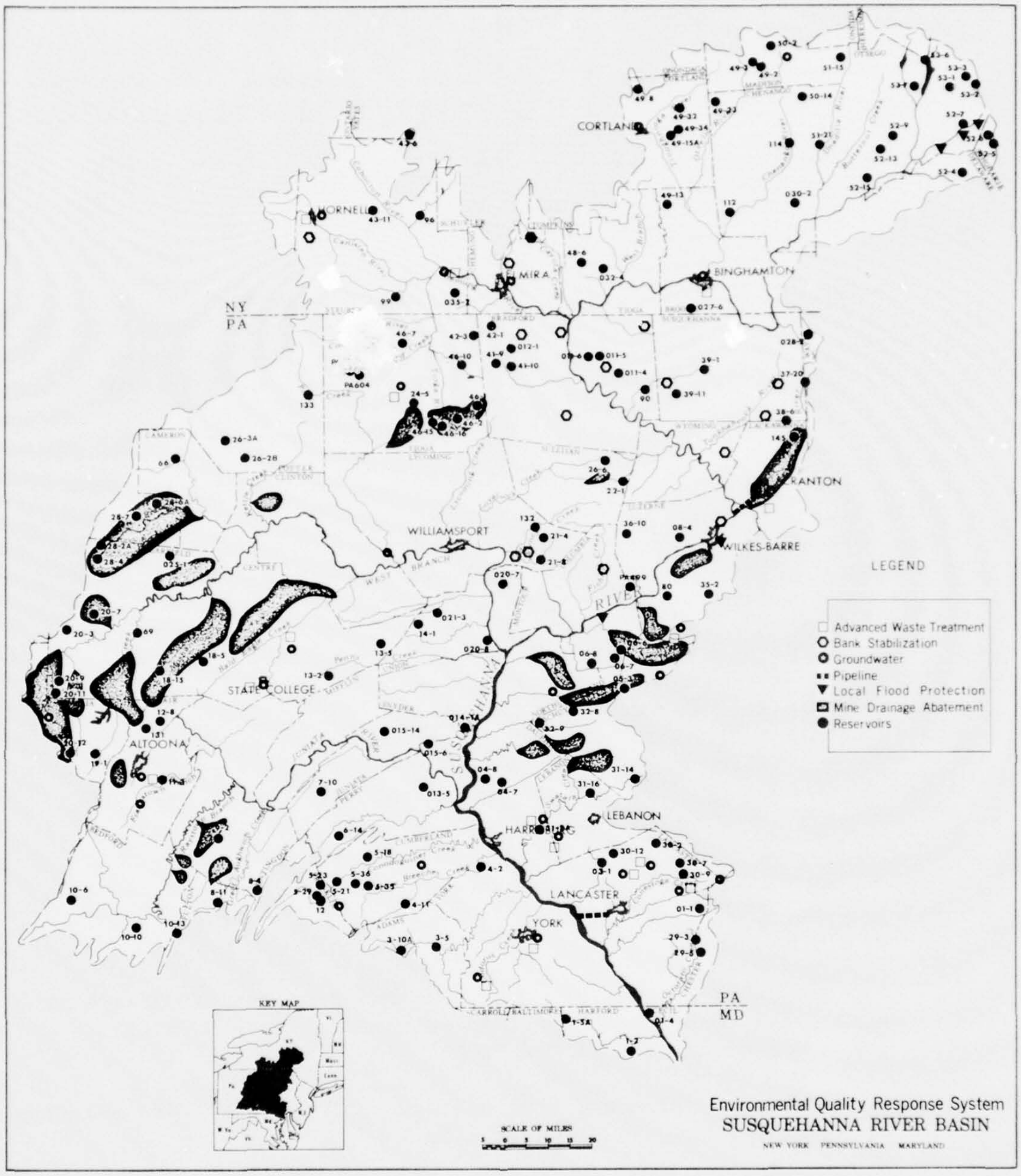
The formulation of a Basin-wide response system for each of the three objectives became a very valuable planning tool in examining and understanding the potential of alternatives. It illustrated those structural and management measures that appeared to be reasonably compatible with all three objectives. It also illustrated some substantial differences among alternative means for meeting the range of needs, as Chapter IX will indicate.

The multiple-objective effort brought to light the specific kinds of water resource development which the Workshop related to regional development, such as recreation reservoirs close to urban areas, an assured water supply, and added flood control. The real difficulty of formulating for a regional objective with the present knowledge of expansion effects was clearly underlined. The environmental quality response system illustrated that, at least for the Susquehanna Basin, most of the more important <u>in-basin</u> water resource needs for years to come could be met without the very large or disruptive projects. This implies that the public would be willing to learn to live with the flood risk and to trade unrestricted boating on the larger water surfaces for streamside recreation and restricted boating. The high costs of pollution abatement to meet the water quality standards, including complete coal mine drainage pollution abatement, were also clearly shown during the formulation of the three response systems.

While the multiple-objective approach has been an effective means of improving plan formulation for this study, some very persistent difficulties hampered its full efficacy:

1. Quantifying secondary (regional income) benefits, and relating these to a specific alternative.

2. Encouraging productive local involvement and establishment of regional goals for economic growth and water resources development.


LEGEND
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Mine Drainage Abatement
Reservoirs
Environmental Quality Response System
SUSQUEHANNA RIVER BASIN
NEW YORK PENNSYLVANIA MARYLAND
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WILLIAMSPORT
WILKES-BARRE
STATE COLLEGE
ALTOONA
HARRISBURG
LEBANON
LANCASTER
YORK
NY
PA
MD

Figure 11

3. Development and analysis of an increased amount of data for a large number of partially comparable alternatives, only a few of which are needed.

4. Determining public preferences for the different forms of water-based recreation, and the relationship of total demand to price.

5. Evaluating relative weights of environmental factors, as well as identifying factors that constitute a "quality environment."

The manner in which these problems have been approached is discussed or illustrated in this Supplement, as well as in Appendix C and Appendix K(1)

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1. Research Planning and Design Associates, Inc., Amherst, Massachusetts

2. Susquehanna River Basin Archeological Resources, John Witthoft, Museum of the University of Pennsylvania, 1968.

3. Sylvester K. Stevens, "History of the Susquehanna River Basin," 1968.

CHAPTER VIII - THE WORKSHOP PLAN AND THE SUSQUEHANNA PROSPECTUS

A. THE PLAN FORMULATION WORKSHOP PLAN

During their May 1968 meeting, the Coordinating Committee recognized that portions of the Basin could be specified for development in line with one or more objectives. The Coordinating Committee members, particularly those representing the three States, were asked to provide the Workshop with their objective preferences as planning guides in formulating the Workshop recommendations for a plan. For example, if the Coordinating Committee designated regional development as the primary objective for a part of the Basin, the Workshop would rely heavily on the response system for regional development in formulating the Workshop Plan in that part of the Basin.

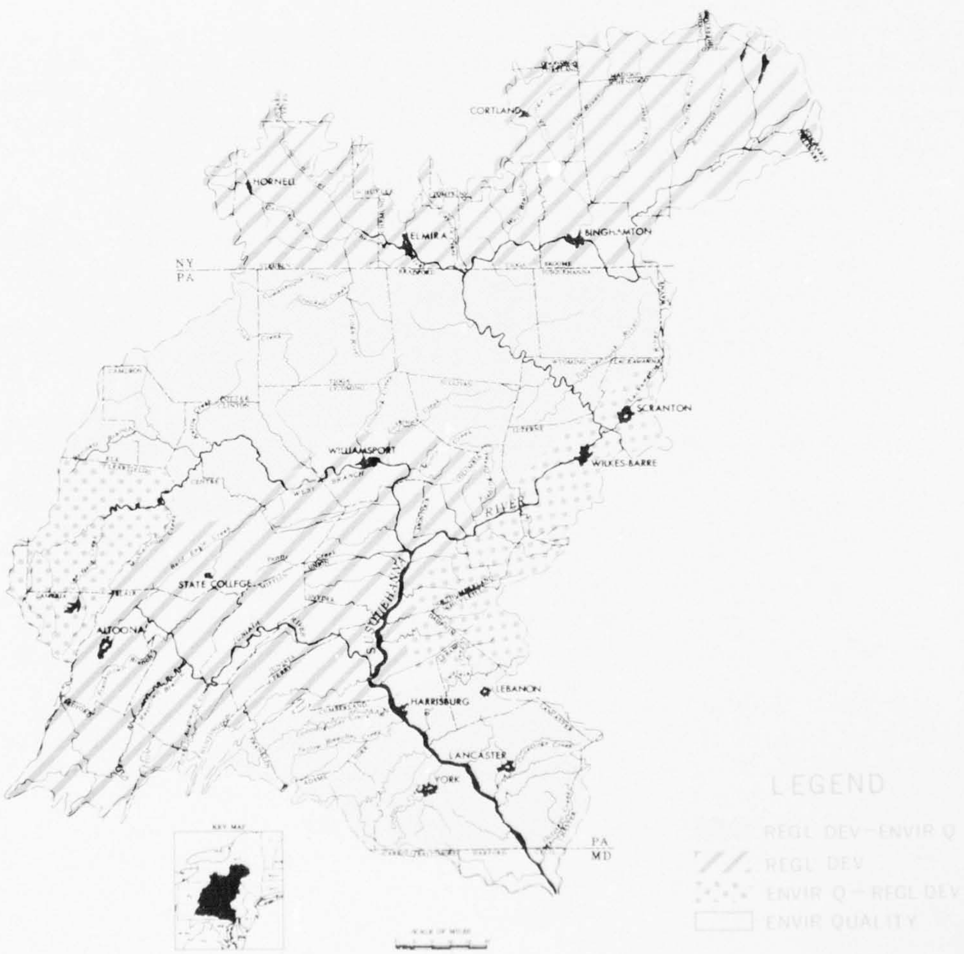
The Workshop received specific objective preferences from each of the three States and from the Department of Agriculture's representative on the Coordinating Committee. The State of New York's representative was interested in regional development as a primary objective, in conjunction with a consideration of environmental quality and economic efficiency. He requested selection of alternatives that would "provide the most good to the greatest number of people living in the region while reflecting the desires of the people living in the area." Further he stated that "reservoirs do not necessarily disrupt the natural beauty of an area, but in many cases actually provide enhancement." In addition, a list was provided of planning considerations, including reservoir projects that, from New York's viewpoint, were necessary to meet water resource needs through the year 2020.

The Commonwealth of Pennsylvania's representative stated that "primary consideration should be given to water quality problem areas." He also provided a map of the Commonwealth portion of the Basin showing the regions to which primary and secondary objectives were assigned (See Figure 12). In addition, he stated that "the main stem of the Susquehanna River could be used to alleviate the deficiencies in recreational demands and serve as the major water supply source for the area."

Maryland stated that "a principal objective of development in the Maryland portion of the Basin is environmental quality, with the emphasis upon water contact recreation, fishing, and boating." A few desirable small reservoir projects, and designated areas and stream reaches for preservation were also listed. Maryland emphasized, however, the overriding importance of maintaining the desirable ecology of the upper Chesapeake Bay estuary. The ecology is dependent, to a large but yet not fully understood extent, on the pattern of flow of the Susquehanna River.

The Department of Agriculture's representative provided an objective preference map for the entire Basin, recommending a specific objective for each delineated region. His preferences are illustrated in Figure 13.

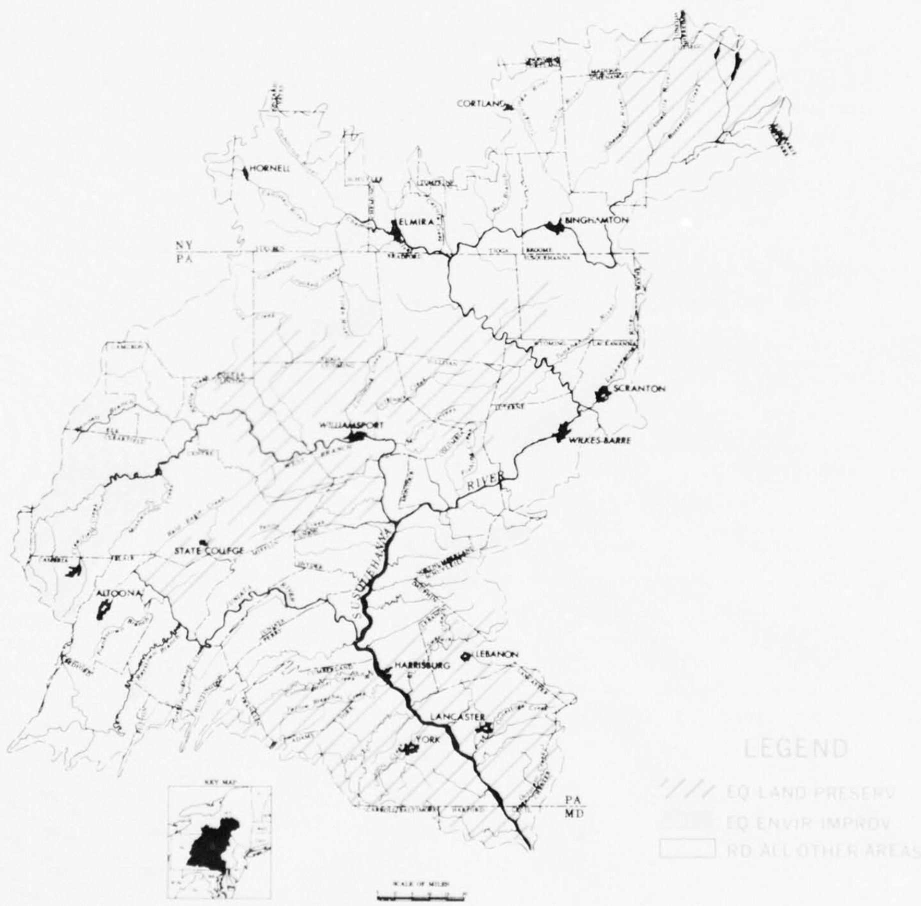
With this guidance from the Coordinating Committee, the Workshop met in early July 1968 to formulate a Workshop Plan for first review during the July meeting of the Committee. The Workshop Plan would include an Early Action Plan (for 1980) and a Framework Plan (to 2020). The Workshop responded to the guidance (written and oral) provided by the Coordinating Committee, but added some of the Workshop members' judgments on pertinent objectives in specific geographic areas. Many of the Workshop participants were in direct contact with their agency or State representative throughout the plan formulation process. They also had benefitted from numerous field contacts with public and private groups in the Basin.



OBJECTIVE PREFERENCES - STATE REPRESENTATIVES Figure 12

Although the preferences received from the Coordinating Committee did not mention economic efficiency, the Workshop was selective in choosing projects for regional development. With some exceptions, most of the project selections for regional development were also economically justifiable from the national viewpoint. Exceptions were made where growth centers would benefit from the project and the Workshop believed the secondary benefits appeared to justify the investment. Because the plan emerging was, in effect, a blend of the three response systems, a blending of the criteria for these systems was used, as appropriate to each location.

The first-cut Workshop Plan exposed to the Coordinating Committee in July 1968 met all water supply and water quality requirements. The level of recreational development provided fell short of the projected demands to the year 2020, at that stage of the plan, but avoided serious



OBJECTIVE PREFERENCES – USDA REPRESENTATIVES Figure 13

environmental quality conflicts. Flood damage reduction relied heavily on flood plain management but some structural measures were included. Coal mine drainage pollution abatement reflected the regional development and environmental quality objectives in the level of correction work recommended.

The Coordinating Committee's comments on the first-cut Workshop Plan provided considerable guidance for further planning. The Committee felt that improved quantification of secondary benefits should be included in the plan formulation process. Although the Workshop used projected population data, location of growth centers, nature of flood damages, projected employment mixes, and need for water supply in formulating for regional development, the Committee urged additional effort in the elusive secondary benefit analysis.

The Committee noted the shortage in meeting the water-oriented recreation day and boating demand projections for 2020. The Workshop had found it impracticably expensive to meet all the projected unsatisfied recreational demand by single-purpose development. Additional reservoir sites were available in some portions of the Basin that would help to meet the 2020 demand if developed for recreation, but not where they were most needed. At many of the sites in the inventory, recreational visitation and benefits are limited by adverse topography. Other sites were very costly because of the required relocation of transportation facilities presently in the valleys. The Workshop found in many instances that the public investment per recreation day was too large to support a recommendation for single-purpose recreational development, particularly on sites with low use potential. Where sites seriously conflicted with the environmental quality objective, the Workshop assumed that the public would prefer, in many areas, developed streamside recreation and free-flowing streams even if it meant they had to go elsewhere for boating.

It should be noted that the early action (1980) Workshop Plan (first-cut) met all the projected recreational needs, including boating. The Workshop found there were sufficient surface water development sites compatible with the objectives to meet the demand in the early action period, but not for later action.

The basic criterion for unrestricted boating selected by the Recreation Subcommittee was for 5 acres of surface water per boat (Appendix G, Part 1, Recreation). This criterion was questioned for the Pennsylvania portion of the Basin as being too expensive to meet, and a greater density was suggested. The Committee recommended, as well, more use of the instream potential as a feasible and non-disruptive means of meeting more of the water-oriented recreation day demand.

The Coordinating Committee also asked the Recreation Subcommittee to make more specific recommendations on stream categories for recreational use, including both location and definition.

The Coordinating Committee noted that the Workshop Plan did not include a detailed program of flood plain management. They asked that the flood plain management programs for the Basin be applied on a reach-by-reach basis, and be further coordinated with the flood forecasting programs of the Weather Bureau, U. S. Department of Commerce.

After the Coordinating Committee had commented on the first-cut Workshop Plan, they requested that the Workshop continue to collect data and refine their selections, and present a completed Workshop Plan at the next Coordinating Committee meeting (December 1968). The Committee members would at that time agree on a Prospectus for water resources development in the Basin as the basis for the public presentations in the early part of 1969. The Prospectus would be the apparent best system of alternatives at that time rather than the firm Coordinating Committee Plan. The Coordinating Committee would not agree on their recommended plan until after the public presentations (see Figure 5, Chapter VI).

With this guidance from the Coordinating Committee, the Plan Formulation Workshop set out to complete its planning assignment. To obtain more information on the regional or secondary impact of potential alternative selections, teams composed of engineers and economists visited locations where regional development was suspected to be water-sensitive, that is, where removal of some water and related land resource development constraint was expected to stimulate the economy. The opinions of local planners on the sensitivity of the town's or region's economy to a key item of water resources development were obtained through a comprehensive questionnaire. Bloomsburg, Lock Haven, and Harrisburg, Pennsylvania were surveyed for their expected sensitivity to flood protection. Elmira, New York and Shippensburg, Patton, and Bedford, Pennsylvania were surveyed to ascertain their sensitivity to multiple purpose water resources development. Altoona and Holidaysburg, Pennsylvania were surveyed for their sensitivity to water supply development and water quality improvement. Renovo and Galeton, Pennsylvania were included for their sensitivity to recreational development. Shamokin, Pennsylvania was surveyed to ascertain its sensitivity, among other items, to coal mine drainage pollution abatement. Appendix C contains a summary of the results of each of these surveys. At the same time as the regional development surveys, the Recreation Subcommittee was responding to the Coordinating Committee's comments on stream recreation by preparing a basin-wide survey of recreational and fishing categories for those streams worthy of designation. The remaining streams would not be categorized. The Recreation Subcommittee also was refining and updating the information on the adequacy of the recreational measures in the Workshop Plan to meet the projected demand to the year 2020.

The Workshop members also reviewed the degree of flood damage reduction afforded by the first-cut Workshop Plan. A flood plain management alternative was selected for each reach throughout the Basin by analyzing the characteristics of the flood damage in that

reach. Selections were necessarily general in relation to a single structure in a reach, but as a basin-wide program represented considerable detail.

The full Plan Formulation Workshop met during September and October of 1968, and covered each of the sub-basins in turn for updated information and suggested changes in the Workshop Plan. The Workshop agreed on a number of changes.* They noted that the 2020 Workshop Plan still did not meet the optimum boating demand, using a design criterion of 5 acres of water surface per boat as optimum density, although there are a number of available alternatives should they become acceptable in the future. The Workshop also discussed whether proposals for wilderness or primitive areas were sufficiently water-related to be included in the Workshop Plan; they agreed to refer this decision to the Recreation Subcommittee.

The September-October meetings concluded the Workshop's assignment received during the July 1968 Coordinating Committee meeting to complete the Plan Formulation Workshop Plan. The Coordinating Committee had requested a report on the Workshop Plan in advance of their meeting in December 1968. This report is included as Attachment 4 in Chapter XI as an item of reference. For the most part, it represents the Workshop's consensus on the comprehensive plan for the Susquehanna Basin prior to changes by the Coordinating Committee to increase its acceptability to the public, and prior to the public discussion phase. The Workshop Plan's specific structural features also are noted in the Plan Formulation Summary Tables, Attachment 3 in Chapter XI.

B. THE SUSQUEHANNA PROSPECTUS

The Coordinating Committee reviewed the Workshop Plan during the December 1968 meeting and made a number of changes (also in Attachment 4) to arrive at the Susquehanna Prospectus intended for first public exposure. The Committee generally agreed that the Coordinating Committee Plan they would eventually recommend should be realistic, practical, and politically acceptable.

The State of New York's representative expressed concern that total benefits** and other detailed project information be available for the public information phase of the study. The Committee agreed that as much detailed information would be available as could be reasonably prepared. New York offered no exceptions to the Workshop Plan, but noted that alternatives should be illustrated in the public information program.

The Commonwealth of Pennsylvania representative indicated that the boating acreage and water-oriented recreation day needs were too high, and that the number of impoundments recommended for early action (1980)

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*The first-cut Workshop Plan, the July 1968 edition, is not detailed in this report, nor are the specific changes for this early version that occurred during September and October of 1968 as a result of the continued efforts of the Workshop.

**Regional and national income benefits combined.

was too great to be politically practical. He believed that taking of agricultural land for recreation and boating would not be acceptable to the Basin public; he would prefer more restricted boating which would allow more boaters to use the same area. He also offered to identify additional low channel dam project locations in Pennsylvania large enough for unrestricted boating for early action (in lieu of impoundments).

The Coordinating Committee deferred to the judgment of the Commonwealth representative and a number of larger impoundments were removed from the 1980 Prospectus to year 2000 or 2020. Although this resulted in a plan that did not meet the projected early action needs, the Committee believed that present political acceptability was of greater concern. Should conditions change, the projects could be reconsidered at some future point in time. They emphasized that the Report could spell out what measures were available to meet the projected level of needs, even if they were not recommended items in the Coordinating Committee Plan.

The Committee agreed that the final Susquehanna Report containing the Coordinating Committee Plan would include specific recommendations for measures to be undertaken in the near future by 1980. Beyond the early action period, the Report would be less specific and identify what appeared to be the best long-range plan at that time without force of full recommendation for implementation. The Coordinating Committee would also recommend several changes in legislation or policy necessary to implement measures in the Early Action Plan.

One Coordinating Committee member asked that a comprehensive and specific flood plain management package be included in the public offering of the Susquehanna Prospectus. Specifically, flood forecasting and evacuation procedures should receive more attention and be considered for every reach in the Basin.

The Committee, after some discussion, decided that possible wilderness or primitive areas would not be added as a feature of the recommended plan since they were not sufficiently water related.

The Coordinating Committee agreed at this meeting that January 30, 1968 would be the cut-off date for new data input to the Susquehanna Study. They also agreed to go ahead with a series of local planning meetings* throughout the Basin to discuss the Susquehanna Prospectus and alternatives, and that the alternatives selected for the three response systems would be given principal attention. Following these meetings the Workshop would be asked to review changes in the Prospectus requested by the local planning participants and recommend action at the next Coordinating Committee meeting in April, before the first Public Forum meetings.* The Committee approved the Prospectus, with changes incorporated, for use at the local planning meetings, stipulating that alternatives be emphasized, rather than "firm" project selections.

*See Chapter X and Appendix A for further information on meetings with the public.

CHAPTER IX - CRITICAL CHOICES AMONG ALTERNATIVES

A. IDENTIFYING THE CRITICAL CHOICES

The intent of this chapter is to outline a selected few cases representing the more complex and important basic choices among the differing means of solving a set of water resource problems. The cases are not intended to be all-inclusive, but to be descriptive of the handling of alternatives without the burden of systematic details. The related secondary choices, on the size of an individual project or on the level of application of a specific program, although important themselves, are not included in this summary.

During the multiple-objective phase of plan formulation, when response systems were developed for each of the three broad objectives selected for the study, two basic patterns evolved. One was a pattern of similarity. At some locations the alternatives selected for each system were essentially similar, or the differences did not result in notable conflicts. The other pattern - one of diversity - indicated those locations where a possible conflict among objectives might exist, as expressed in the selection of solutions to a problem. Many of these locations of potential conflict are where the "critical" choices had to be made.

Not all "critical" decisions have to be immediate, nor are they equally difficult. In general, the choices for early action implementation (by the year 1980) require early decisions, particularly if they require a relatively long lead time to carry out. The difficult choices very often are those that involve the sharpest controversy or invoke local public reaction. The choices selected for this chapter are not all immediate, nor are they all controversial. All are important, however, since they determine the character of the comprehensive plan in the affected parts of the Basin. In addition, they represent the five most complex types of systems problems encountered in the study.

The structural alternatives identified as possible solutions to the projected needs of the several "critical" choice areas are sufficiently interchangeable to require rigorous systems analysis. The purpose of such analysis was to help in selecting the optimum development plan through the year 2020, consistent with the broad regional objectives and criteria selected for each area. At the same time, the basin-wide system must satisfy: (1) the complex and persistent water resource needs within the Basin, and (2) the minimum flow requirements to maintain the sensitive ecological balance of the upper Chesapeake Bay.

The systems output influenced the decisions, first of the Plan Formulation Workshop, and later of the Coordinating Committee. The results were used during plan formulation to eliminate the less desirable system combinations and, later, to make final plan selections.

Systems analyses of Sub-basins I and II were made concurrently by the Coordinating Committee staff and, to a greater depth of detail, by the firm of Tippetts-Abbett-McCarthy-Stratton (TAMS), consultants to the New York State Conservation Department, Division of Water Resources. The results of the TAMS effort for the New York portion of the Basin are shown in Appendix B, New York Report.

The two analyses, although differing somewhat in methodology and detail, yielded very similar conclusions affecting the major plan formulation choices. As an example of the differing approach, TAMS reflected several levels of ground water development, while decisions on the level of ground water development made in the initial stages of the Coordinating Committee evaluation were considered constant for all systems tested.

Other differences in method involve the computation of benefits. The Coordinating Committee procedures described in Appendix C, Economics and Geography, for the most part reflect current Federal practice and guidelines; TAMS developed a somewhat more independent set of benefit measurement criteria. Both groups used the least costly alternative as the imputed value of added water; however, TAMS reflected inflationary trends in construction costs by not applying time-value of money concepts. The TAMS results yield average annual low flow benefit values significantly higher than those computed by the Coordinating Committee staff and shown in either Appendix C or Appendix K(2), The basic flood control and recreation benefits were computed by similar methods in both analyses, but there were some differences in application and in the estimates of future recreational use.

The significance of the similar results of the independent approach should not be overlooked. The water resource problems of the two subbasins were approached from different viewpoints, applying somewhat different analytical criteria. It is particularly revealing that both approaches yielded essentially the same conclusions affecting the important choices for the comprehensive plan in New York. The Coordinating Committee wishes to acknowledge the contributions of the TAMS effort in the overall systems analysis task.

B. THE UPPER SUSQUEHANNA BASIN IN NEW YORK (SUB-BASIN I)

The water resource needs of this sub-basin, through the year 2020, are illustrated and discussed in Supplement B. The urban centers of Binghamton and Cortland will experience the greatest demand for additional water supply, and the most serious water quality problems during drought conditions. Irrigation needs and flood damages are anticipated throughout the sub-basin, as well as a growing shortage in outdoor recreational opportunity. Meeting these requirements dictated the examination of a range of possible solutions and generated a number of "critical" choices.

Flood Damage Reduction

The New York State portion of the Susquehanna Basin at one time was severely plagued by floods. Due to investment in an extensive protection system, the problem has since been greatly alleviated. The major elements of this system in Sub-basin I are the East Sidney and Whitney Point reservoir projects; levees and channel improvements at Binghamton, Oxford, Greene, Lisle, Whitney Point Village, Nichols, Endicott, Vestal and Johnson City; and channel improvements at Oneonta, Unadilla, Bainbridge, Conklin-Kirkwood, Sherburne, Norwich, Cortland, Cincinnatus, Port Dickinson, and Owego.

A significant potential in terms of average annual flood damages throughout the sub-basin still remains, however. Not adequately reflected in the average annual damages is a related risk. The 1935 and 1936 floods of the Chenango and Susquehanna Rivers caused extensive damage in the Binghamton area. Afterwards, the U. S. Congress authorized the construction of a flood control system consisting of levees, flood walls, and seven upstream reservoirs. The walls and levees have been built approximately as planned, but only two of the reservoirs, the East Sidney and the Whitney Point projects, are now in place (see Chapter II, Figure 1, for location). The effect of the five missing reservoirs is a void in the pattern of minimum protection, increasing the risk of overtopping the Binghamton levees, even though the remaining average annual damages may be misleadingly low.

The 1936 flood on the upper Susquehanna, although the largest in recent history, is not the largest which could reasonably occur. Admittedly, the very large floods are infrequent, but a flood risk to Binghamton still remains. For instance, a large regional flood (Standard Project Flood) would overtop the levees along the Susquehanna and the Chenango by 14 and 8 feet respectively, and devastate about 9,000 acres of prime areas to depths of up to 20 feet.*

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*See "Flood Plain Information - Broome County, New York - Susquehanna and Chenango Rivers." Prepared by U. S. Army, Corps of Engineers, Baltimore District for the Broome County Legislature, December, 1969.

The choices for the Binghamton area, as well as the unprotected areas of the sub-basin, include construction of flood control reservoirs, including headwater projects. Another choice, as far as Binghamton is concerned, would be to raise the existing walls and levees. This would mean reconstructing the walls, since they were not designed to be raised at a later date. Another alternative is a strong flood plain management program, including advance warning of disastrous flood levels, especially for the unprotected areas. Flood insurance, while it doesn't eliminate or reduce the risk of flooding, is helpful in minimizing the financial impact of a flood on individual property holders on the flood plain.

One final alternative would be to do nothing more. While the responsible planner cannot dismiss the problem that easily when people's lives and many millions of dollars of property values are affected, it remains a legitimate choice if accepted by the public with full knowledge of the risk. Usually, no single alternative is the best answer; some combination of two or more choices often prevails.

When examining the three response systems for Sub-basin I (Chapter VII) from the flood damage reduction viewpoint, contrasting solutions can be noted. The alternatives that were screened out as <u>not</u> meeting the criteria of any of the three objectives included reconstructing Binghamton's levee and flood wall system*, all other local flood protection work (except for a channel improvement at Marathon on the Tioughnioga River), and the alternative to "do nothing." On the other hand, the strong alternatives that offer the basic choices to reduce the flood risk would be: (1) develop reservoir storage (as part of a multiple purpose system), including small headwater projects for the upstream areas, or (2) impose an <u>effective</u> flood plain management program. Flood insurance would be a useful supplement to either solution.

General Outdoor Recreation

An important problem in this sub-basin is to meet the projected water-based recreational demands and at the same time retain the high scenic values. Many miles of natural stream could be made available and developed for streamside recreation as one alternative. The stream could provide for a part of the recreational day demand anticipated by 1980, but the width and depth of the streams during the recreation season is generally suitable only for small boats. The remaining boating recreational demand for 1980, depending on the capacity selected, would require a significant area of new water surface in units over 500 acres in size. (See Attachment 1 for Sub-basin I.)

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*The high cost in relation to benefits of reconstructing flood walls and raising levees would not meet economic efficiency or regional development criteria; further height to the protection would violate the aesthetic criteria of the environmental quality objective.

If no additional surface is developed, the existing lakes and reservoirs may absorb a part of the fast increasing demand, but the remainder will go elsewhere - a lost opportunity for this sub-basin's future, but a valid alternative if undertaken in the best interests of all the area's residents.

The Coordinating Committee also has recognized that a comprehensive plan for water resource development should designate selected high value stream reaches that could be managed indefinitely for recreation essentially in their free-flowing condition. This is one step toward seeing that scenic, recreational, fishing, cultural, and historical values are retained and enhanced.

The alternatives, then, that offer the basic choices can be summarized as one or a combination of: (1) developing and managing the streams for general recreation to the extent practicable, (2) developing more water surface areas by reservoir construction, including small headwater projects and low main stem dams, and (3) doing nothing more - with or without protection for the existing stream potential.

Examination of the three objective response systems shows contrast mainly in the combination of reservoirs selected on tributary streams and in the headwaters to improve the recreational opportunity. (See Figures in Chapter VII.) All three systems assumed some degree of use of the existing stream recreational potential and, where possible, augmented by some reservoir recreation. Only the "do nothing" concept violates all three objectives, particularly if "doing nothing" leaves the stream potential unmanaged where threatened by destructive streamside development.

Water Supply

In Sub-basin I, a number of alternative water sources are available. At some locations, ample water could be taken indefinitely from nearby surface sources, mainly the larger streams. At others, reservoir storage would be required to augment streamflow during droughts. Wells tapping ground water aquifers, or pipelines from more distant sources, could also be desirable and economical solutions. Wastewater reuse and reduced water use is possible in some cases, particularly for industries.

For communities such as Binghamton and Cortland, where the largest future water shortages are anticipated, use of reservoir storage and additional ground water development could meet the regional development objective, as long as the source will yield sufficient amounts of good water, reasonably priced. The environmental quality goal is more restraining on selection among alternatives. Properly designed pipelines and ground water wells*, however, do not damage the environment, and the blue waters of carefully located reservoirs enhance most environments. If the source and quality is adequate, and if the environment is not damaged, cost then becomes a deciding factor in choosing among alternative water supply sources. In effect, the economic efficiency objective here is nearly synonymous with regional development, and possibly compatible with environmental quality on an individual project basis. Examining first the Binghamton area (including Endicott), the study projections (see Attachment 1) show that if new sources of dependable water supply are not developed, there could be serious water shortages before the year 2000. By 2020, the combined requirement could be more than 100 million gallons daily greater than what is now dependably available.

The alternative sources for the Binghamton area, as indicated in the three response systems, are reservoir storage and added ground water development. The reservoirs which would be effective for flood control could also be used effectively for water supply storage. Multiple purpose projects upstream on tributaries to the Susquehanna would be particularly attractive. Steady releases could be made from these reservoirs during droughts to assure adequate water for domestic, industrial, and agricultural use.

Ground water is also available in the Binghamton area and is presently in use to meet a part of the total demand. The cost of new ground water development adequate to meet the need at Binghamton, however, appears to be substantially higher than that of storage allotted in a moderately large multiple purpose reservoir upstream. The same approach was used to analyze water supply shortages at each community in Sub-basin I. At Cortland, on the other hand, the relative costs of ground water and reservoir storage appear to indicate that ground water would be a more economical alternative for water supply than reservoir storage.

The irrigation water requirements in this sub-basin by the year 2020 indicated that about 10,000 acre-feet of additional water should be stored at locations upstream from Binghamton in the Susquehanna River watershed. Failure to provide this storage, from either ground or surface sources, will result in depleted natural streamflows during droughts for the Binghamton area's municipal and industrial use in the future, unless strong restrictions are placed on irrigation withdrawals.

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*Provided they do not deplete natural drought streamflows or require large artificial recharge areas stripped of vegetation.

Water Quality Management

The pattern of anticipated water quality problems in Sub-basin I very closely parallels that of water supply; the Binghamton area and Cortland will become critical locations between 1980 and 2000 (see Figures in Supplement B).

Assuming that both the Binghamton and the Cortland areas keep pace with their expected growth by providing collection and treatment of wastes to the secondary level, alternative solutions are available to prevent degraded stream conditions during very low flow periods. One would be to augment the low flows at the two communities by releasing stored water from upstream reservoirs. Another solution would be a level of advanced waste treatment substantially beyond the secondary level. A third partial or full solution would be to reduce the level of wastes produced (and introduced to the stream) below the projected amount, particularly during the most critical periods of low flow.

As they relate to the Binghamton area, the basic choices developed between storage in multiple purpose reservoirs upstream from Binghamton in response to the economic efficiency and the regional development objectives, and advanced waste treatment with much less low flow augmentation in response to the environmental quality objective.* For Cortland, storage at the same multiple purpose reservoir site (49-32) was selected as compatible with all three objectives; advanced waste treatment was eliminated as a less desirable (or less efficient) alternative in multiple purpose systems. Reduced waste loading was treated as indicated in Chapter VI under "Screening of Alternatives."

Analysis of Alternative Systems

As indicated earlier in this chapter, detailed studies of the most promising alternative systems in Sub-basins I and II were contributed by the State of New York through a consulting engineering firm (TAMS). Both the Plan Formulation Workshop and the Coordinating Committee members were provided the results of the TAMS analysis which did not materially differ, with respect to identifying the apparent optimum system, from the independent efforts of the Workshop participants. Appendix B, New York Report, contains a summary of the TAMS systems data, including their comparative analysis of the Susquehanna Prospectus. Following the TAMS studies, alternative site 49-28 (Fabius project) in the Tioughnioga River headwaters was added to the Prospectus to replace site 49-32, since it appeared to be a more efficient project. Site 49-32 remains a primary alternative. On Charlotte Creek, the TAMS and the Workshop data favored selection of sites 121 (Davenport Center project) and T-2 (just upstream) as the key elements of a Charlotte Creek Complex. Also, the Workshop analyses and the TAMS studies both pointed to the long range need for development of reservoir storage somewhere in the Unadilla River watershed for multiple uses. Site 115 (East Guilford project) appeared to be the most favorable site over other possibilities, but this latter decision can be postponed. Appendix K(2) contains detailed information on the selected projects.

*Reservoir sites selected for the environmental quality objective in Sub-basin I contained insufficient storage for low flow augmentation for Binghamton to the year 2020.

The basic choices, as outlined, to meet the needs and objectives in Sub-basin I, particularly for the Binghamton area, were resolved by both the Workshop and the Coordinating Committee generally in favor of multiple purpose reservoir storage of modest proportions at selected sites, as opposed to single-purpose, non-reservoir solutions. (Attachment 6 summarizes the Coordinating Committee Plan's effect on low and high flows at Binghamton.) Further study by the Susquehanna Regional Water Resources Planning and Development Board* will continue after publication of the Susquehanna River Basin Study. The Susquehanna Board is charged under State law with preparing a comprehensive water resource plan at the regional and local level; it will be in a position to refine basic decisions among alternatives. Final determinations on a reservoir project for the Tioughnioga River headwaters and on the specific nature of a Charlotte Creek complex will represent critical early action decisions that this Regional Board will influence. The role of the Unadilla River will pose a key longer range question for management of the area's water resources.

C. THE CHEMUNG RIVER BASIN (SUB-BASIN II)

The pattern of resource problems in the Chemung Basin is similar in many respects to the upper Susquehanna in Sub-basin I. Supplement B illustrates the water resource requirements expected through the year 2020 in the Chemung Basin. It is apparent that recreation will be a widespread demand while flood control problems and irrigation needs will be more limited to parts of the sub-basin. The Elmira and Corning, New York areas will be the centers of the water supply and water quality problems that are expected to develop. Pollution of the upper Tioga River by coal mine drainage is also a problem, and one not found in Sub-basin I.

"Critical" choices among alternatives to meet the Chemung Basin's water problems primarily relate to the water supply and the water quality management requirements at Elmira, and the need to reduce flood damages along the unprotected flood plains of the Cohocton River upstream from Elmira. Unsatisfied recreational demand presents a problem similar to Sub-basin I, but without the same potential for conflict of choice among alternative solutions.

Water Supply

The same general solutions to water supply problems apply in the Chemung Basin as in Sub-basin I. These choices include ground water development, reservoir storage, additional reuse, and reduced use. The three objective response systems developed to assist in plan formulation vary in the selections to meet water supply demands primarily in the role of ground water at Elmira.

*Established in 1967 by the New York State Water Resources Commission under Part V, Article V of the State Conservation Law.

If dependable new water supply sources are not developed, the Elmira water service area could face severe shortages during droughts after 1980. Unless corrective measures are taken, the community's growth may be adversely affected by an inadequate water supply.

The three response systems made varying use of reservoir storage and ground water as the most likely alternative water sources for Elmira. As far as reservoirs are concerned, several upstream sites have the capacity to furnish enough water to meet the requirements of Elmira. Site 96 (Mud Creek project) appears to be the most economical to develop for multiple use.

The quantities of ground water in and around Elmira are limited in relation to the year 2020 expected demand. If such demands are to be met by this source, major (artificial) aquifer recharge facilities must be provided*. Construction and operation of these facilities would be more costly than reservoir storage. However, limited quantities of ground water that would use the resource to its ultimate capacity without artificial recharge could be a means of supplementing the Elmira supply from reservoir storage. The two systems would be jointly operated to the maximum advantage of both.

Water Quality Management

Even with treatment of wastes to the secondary level (85 percent removal of biochemical oxygen demand), Elmira will be the critical point for managing water quality in the Chemung Basin during low flow periods. Alternatives to prevent degradation of the Chemung below the water quality standards include advanced waste treatment, reservoir storage for low flow augmentation, and reduced wastes during critical periods (see Chapter VI under Screening of Alternatives).

The three response systems developed a basic choice between storage in at least one moderate-sized multiple purpose reservoir project (economic efficiency and regional development objectives), and advanced waste treatment (environmental quality). The conflict here, unlike in Sub-basin I, is not between storage and loss of agricultural lands, but a conflict between alternative uses of a more limited reservoir storage potential. Advanced waste treatment for Elmira entered the environmental quality objective to reduce the impact of drawdown at reservoir sites and to reduce storage requirements solely for water quality management. This was in recognition of the value of the incremental storage for recreation and scenic enhancement not fully reflected in the recreation "user" benefits for the environmental quality response system.

*The recharge facilities themselves could be a hindering restraint to growth, depending on where located, possibly violating the regional development objective. The recharge areas also have the potential for violating the environmental quality criteria if large unvegetated areas are needed.

Flood Damage Reduction

The need to reduce flood damages has been eased from past conditions by the existing flood control reservoirs at Arkport and Almond, the local flood protection projects at Elmira, Corning, Bath, Hornell, Avoca, Canisteo, Elkland, Addison, and Painted Post, as well as several small watershed projects. In addition, two authorized major flood control reservoirs, the Cowanesque Project on the Cowanesque River, and the Tioga-Hammond Project on the Tioga River and Crooked Creek, are now in the preconstruction planning stages. Both will provide substantial reduction in the flood loss risk. (See Chapter II, Figures 1 and 2 for projects assumed completed.)

The Cohocton River flood plain, downstream from the mouth of Fivemile Creek, remains an area of potential flood damage concentration in the Chemung Basin. The general choices for this area, as well as for the unprotected portions of the Chemung River just downstream, are flood plain management, reservoir storage, and local flood protection. Flood insurance was considered a useful supplement regardless of the system combination selected. The choice to "do nothing," unlike water quality where the standards bear the force of law, could be a valid alternative if adopted with full knowledge of the risk by the responsible representatives. For the Cohocton, the "do nothing" alternative guarantees growth of the potential loss to floods.

The three objective response systems, from the flood damage reduction viewpoint, screened out all local flood protection projects for the Cohocton and the Chemung as meeting the criteria of none of the three objectives. Flood control storage, particularly in headwater projects, was provided under all three objectives to the extent permitted by the criteria of each. The regional development objective, as expected, generated the most reservoir projects. The most extensive flood plain management programs to complement the flood protection systems would be required under the economic efficiency and environmental quality objectives. The "critical" choice essentially is between investment in an effective program of flood plain management (with little investment in reservoir storage of flood waters), and a program to reduce flood stages by developing relatively small multiple purpose and some single purpose reservoir projects. The latter alternative, reflecting regional development goals, would still require a flood plain management program supplemented by an appropriate level of flood insurance.

Analysis of Alternative Systems

Meeting the water resource problems in the Chemung Basin, particularly after 1980, will be relatively more difficult, with less flexibility in choice among solutions, than in the rest of the upper Susquehanna Basin. The constraints imposed by the limit on the extent and quality (hardness) of ground water near Elmira, the major need center, reduce the number of possibilities to review in a systems context.

The TAMS studies for Sub-basin II concentrated on the problems in the New York portion of the sub-basin. Their analyses are shown in Appendix B, New York Report, with a comparative analysis of the Susquehanna Prospectus. The TAMS analyses indicated that multiple purpose Mud Creek project (site 96) would be economically feasible, using economic efficiency criteria, but that additional major reservoir projects would not meet the efficiency criteria test. Systems studies by the Coordinating Committee staff yielded similar conclusions under the economic efficiency objective.

Under the regional development objective for the area, the Plan Formulation Workshop had added site 43-11, mainly to further reduce flood levels on the Cohocton River for early action implementation. Long range shortages in water supply and water quality control at Elmira would be satisfied by a combined system of ground water development and advanced waste treatment at Elmira, augmented by conversion of a part of the flood control storage in the tributary Tioga River Basin to conservation storage for low flow augmentation. The remaining flood damages would be the subject of a flood plain management program. Based on the TAMS studies, the Coordinating Committee agreed to modify the Susquehanna Prospectus to include the Fivemile Creek project (site 97), under the regional development objective, as a multiple purpose site for early action. Site 43-11 was deleted as a component of the Prospectus, along with ground water development for water supply at Elmira and Bath.

The "critical" decision in this sub-basin develops as the choice to construct a multiple purpose reservoir on Fivemile Creek to satisfy regional development goals, or to draw heavily on ground water at Elmira for water supply, augmented by an intensive flood plain management program for the Cohocton River (site 43-11 is not nearly as effective as the Fivemile Creek site particularly for flood control on the upper Cohocton). The Coordinating Committee chose the major reservoir alternative, reflecting the regional development interests of the State of New York as a planning partner.

The Chemung Regional Water Resources Planning Board, organized in 1969 under New York State law, must face important choices in Sub-basin II when preparing the comprehensive plan for which they are charged. The decision on the Fivemile Creek project will be particularly pertinent, since present Federal policy does not permit its construction by a Federal agency.

D. CONODOGUINET CREEK (IN SUB-BASIN VII)

The dominant requirements for water resource development in the Conodoguinet Creek area include water supply (municipal, industrial, and agricultural), water quality management, and increased recreational opportunity. These requirements are illustrated and described in Supplement B. The communities affected are Carlisle, Shippensburg, and the Harrisburg (West Shore) suburbs of Camp Hill, Mechanicsburg, and New Cumberland.

The alternatives most prominent during the multiple-objective formulation process for the three response systems for water supply included ground water (hardness of water was noted), diversion pipelines, and reservoir storage. Advanced waste treatment, diversion sewer construction, and low flow augmentation from reservoir storage were examined for water quality management (secondary level of treatment assumed), while streamside development, low channel-type dams, and reservoirs were considered for increasing the recreational opportunity. A number of potential system combinations were found to be feasible and within a reasonable range of competitive cost.

Examination of the three response systems showed that no one of the systems, as formulated, provided a fully satisfactory answer to the problems in the Conodoguinet Creek area. Also, some decisions on alternatives made during the formulation of the three response systems had been based on relatively narrow margins of choice as they related to costs and benefits. Subsequent improvements in the preliminary data (mainly on the cost of alternatives) outdated decisions made earlier in the formulation stage for economic efficiency and regional development, since the relative order of merit changed in response to the criteria of each objective. The alternatives primarily affected in their relative ranking were development of ground water for municipal and industrial water supply, and the construction of a water supply pipeline from the Susquehanna River for the West Shore area.

Analysis of the alternative system combinations was carried out by the Coordinating Committee staff to include all alternatives available to meet the water supply and water quality demands projected for the Conodoguinet Creek area. The apparent optimum total system was the object of analysis, including the recreational and fish and wildlife impacts.

The "critical" choices for the Conodoguinet Creek area are closely keyed to municipal and industrial water supply. For Carlisle and Shippensburg, the alternatives narrowed to use of ground water or withdrawal of surface water from Conodoguinet Creek. For the West Shore communities, Mechanicsburg, Camp Hill, and New Cumberland, the choices are the Susquehanna River, or again, use of Conodoguinet Creek augmented by reservoir storage. Since use of Conodoguinet Creek is common to all three service areas, comparative analysis of reservoir alternatives to provide adequate storage became a first step.

The staff investigations yielded two feasible sites near Shippensburg, the Shady Grove site (12), and the Mongul site (13). Since both reservoirs would have about the same regional development and environmental quality effects, the choice is one of economic efficiency. Shady Grove appears to be the more economical site.

If Shippensburg is to use water from the reservoir, a pipeline would be required. The cost of this pipeline (no storage allocation appears to be necessary) would be about half that of ground water development. To use water released from reservoir storage, Carlisle would require an intake in Conodoguinet Creek. The cost of the intake system and the cost of the necessary storage upstream in the Shady Grove reservoir would be more economical than the ground water development cost.

The highly developed areas of the West Shore lie along the Susquehanna River. The direction of development is away from the River, generally up the Conodoguinet Valley toward Carlisle. A pipeline from the Susquehanna River could serve this new development, but must be constructed through or around the already built-up areas. This pipeline would cost about 1-1/2 times the cost of using water released to Conodoguinet Creek from the Shady Grove reservoir. The primary supplier of water to the West Shore is presently constructing a water supply intake on Conodoguinet Creek.

The optimum system for the Conodoguinet Creek area involves reservoir storage at the Shady Grove site to meet water supply requirements and to improve water quality management, advanced waste treatment as the principal water quality safeguard, and ground water development for irrigation use. The critical and basic choice to this system is construction of a major reservoir project; the alternative for water supply would be to rely on ground water (with some treatment to reduce hardness), and a future pipeline from the Susquehanna River to the West Shore, when the undeveloped supply in Conodoguinet Creek becomes inadequate.

E. CODORUS CREEK (IN SUB-BASIN VIII)

The Codorus Creek Basin contains a number of growing communities of moderate size that depend to some extent on the Basin's water resources to help support continued growth. The size of the communities and their water resource demands are large, however, in relation to the size of the drainage area. The result is a projected deficit in the resource base -- a deficit large enough to require significant investment to assure a solution.

Supplement B summarizes the water resource requirements for the Codorus Creek Basin through the year 2020. Water supply for municipal and industrial use and water quality management are the important requirements for which the critical decisions must be made. These same demands are repeated in other small Piedmont drainages tributary to the lower Susquehanna River. Solutions in the Codorus Creek area could represent a regional pattern for the Piedmont area of the Susquehanna Basin.

Water Supply

The communities of York, Spring Grove, and Hanover, at the fringe of the Codorus Basin, are the principal water service areas generating a demand for water supply. Critical water shortages are not new to the area. The drought of the summer of 1966 depleted the reservoir storage for York to the point of exhaustion, requiring the importation of water for critical uses by tank truck. Since the 1966 crisis, an additional storage reservoir was completed that will avoid a recurrence of crisis conditions for a number of years, depending on York's rate of growth and the severity of future droughts. The basic problem of an insufficient water resource within the Codorus Basin still remains, however.

The choices for York, projected as the critical water supply deficit area along Codorus Creek by about 1980, include ground water development, additional reservoir storage, and a pipeline from the Susquehanna River. None of these alternatives considered in the three response systems provides a simple solution to the York area water supply problem. Reservoir sites are very limited and relatively expensive; ground water (some sources hard) is available, but would require a large number of wells spread over a considerable collection area; a pipeline from the Susquehanna would provide an adequate supply of reasonably good quality, but the cost of the pipeline also would mean a significant investment. The pipeline, however, has potential for regional application beyond York (for Spring Grove and Hanover, for instance) that could reduce York's share of the cost by combining other communities in the use of the Susquehanna River source. The pipeline appears to be the least costly long range solution to the York water supply problem, with the potential for significant savings if a regional system is adopted.

Water Quality Management

A substantial need is indicated for water quality management in the Codorus Creek Basin, beyond secondary treatment of municipal and industrial wastes. The choices considered during the three-objective formulation stage included advanced waste treatment at each sewer service area where it would be required, and interceptor sewers to divert wastes treated to the secondary level to the Susquehanna River. Low flow augmentation from limited reservoir storage, although of value, would not be sufficient to meet the required water quality standards and was eliminated as a practicable solution. Analysis of the alternative systems indicated that an advanced waste treatment plant for each sewer service area, where it would be required, would be a better solution than collection and diversion of secondary waste effluent to the Susquehanna River.

To test the feasibility of a broader-based regional solution to the kind of water quality management problems anticipated in the Codorus Creek Basin, the Coordinating Committee staff prepared a preliminary "case" study of the feasibility of a combined or regional system of waste treatment facilities. The reconnaissance-level study was not limited to consideration of only those individual areas requiring advanced waste treatment (York and Hanover), but to the five sewer service areas in the Codorus Creek Basin for all levels of treatment.*

All likely combinations of collection and treatment facilities were considered: studied were a total of 36 individual possibilities ranging in complexity from individual waste treatment plants to a fully combined system serving all five sewer service areas. The study results indicated that full regionalization of the sewage treatment facilities of York County would be somewhat less costly than the continued development of individual service area plants.

It was not possible, based only on the reconnaissance-level study, to make a positive recommendation for regionalization in the Codorus Creek Basin using economic feasibility as a foundation. The margin of savings, between the average annual costs estimated for the apparent most efficient regional system and for the recommended system, was not sufficient to rely on preliminary results.

Several considerations, not evaluated in the analysis, seem to favor full regionalization of sewage treatment in York County. For instance, with combined treatment facilities at York, upstream pollution from municipal and industrial sources could be virtually eliminated, rather than managed within stream standards of tolerance. The implication of this improvement goes beyond the general upgrading of water quality upstream from York. The Indian Rock Dam on Codorus Creek provides flood control for York (see Figure 1 in Chapter II for location). The project, completed in 1942 as a "dry" dam, has never contained a conservation pool for any purpose. Recreation water surface, in short supply in the immediate York area, might be developed if water quality (including color) could be improved to an acceptable level for impoundment. A regional waste treatment system that included at least Spring Grove could open the way for multiple purpose use of Indian Rock Dam.

The important regional water quality choice for the Codorus Creek Basin becomes one for which further analysis beyond the comprehensive study level would be required and definitely warranted. The individual communities could continue to develop their own sewage treatment systems to meet their local stream quality standards. On the other hand, substantial savings in cost, improved reliability of plant operation, and better overall stream quality could result from a decision to pursue a regional system of water quality management, keeping in mind the potential for parallel development of a regional water supply system.

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*The five service areas include York, Spring Grove, Hanover (Penn Township), Dallastown-Yoe, and Red Lion.

Consumptive Losses and Diversions

The rapid growth in population and the expanded economic activity forecasted for the Susquehanna River Basin will result in a marked increase in water withdrawals for municipal, industrial, and irrigation purposes (see Attachment 1), as well as cooling water for thermal electric power generation. Much of the water will be used and returned to the streams, to be either reused downstream or to flow on to the Chesapeake Bay. A significant percentage, however, will be consumed (evaporated) and lost to the system. In addition, there are two significant transfers of water out of the Basin now underway. It appears that both of these transfers will increase in the future, further reducing the quantity of water at the mouth of the Susquehanna River.

By the year 2020, total maximum monthly consumptive losses, including interbasin transfers, are projected to be about 4,000 cubic feet per second (cfs). Of that amount, 820 cfs of total consumptive loss would result from the projected thermal power generation (see Appendix H). This loss is based essentially on present power generating practices and stream water quality standards for temperature. It does not reflect possible major advances in technology. New methods of power production are evolving which could provide higher generating efficiencies, or require minimum cooling facilities, both of which could reduce consumptive losses considerably. Also, with the advent of high voltage interconnections, it is now possible to economically locate power generation plants in areas quite remote from the area of need. For these reasons, it appears that the only thermal cooling losses which can be predicted with any degree of certainty are those for the near future (1980). The projected consumptive loss of 820 cfs by the year 2020, however, represents the best estimate at this time and was used as the long range planning target. The thermal power (cooling) consumptive losses can be re-evaluated in the future based on the information then available.

The municipal and industrial water demands in the Susquehanna Basin will also increase significantly during the next 50 years, with the corresponding consumptive losses in the return flow during the critical month expected to reach 1,200 cfs. Monthly municipal and industrial water demands may vary from about 80 percent of the yearly average during the winter months to about 125 percent in the summer. Likewise, consumptive losses also may vary from about 10 percent of each month's average demand in the winter to 25 percent or more in the summer. There appear to be no practicable changes in technology or management on the horizon that would significantly alter these patterns, except for unforecasted decreases in industrial demands per unit of output. Foreseeable changes, however, have already been reflected in the projected water demands (see Appendix F).

Accompanying the increases in water use for municipal and industrial purposes would be an increased demand for irrigation water. These losses must be subtracted from the natural river flows that normally would be available at downstream water service areas. Withdrawals for irrigation generally occur during the months of June through September, July and August being the months of greatest use. By 2020, the critical month's demand may reach an average of 670 cfs for the month. These demands were considered as completely lost to the river system, since the great majority (70 percent was assumed) either evaporates or is transpired by the using plants. The surplus water applied enters the ground water supply or runs off as surface flow. Some of the surplus may eventually find its way back to the streams but cannot be counted on during a critically low stream flow period.

Baltimore, Maryland and Chester, Pennsylvania are partially dependent upon the Susquehanna River for municipal and industrial water supply. Withdrawals by these communities (see Chapter II) are the only significant interbasin transfers of water now authorized. Chester has recently requested an increase in its authorized withdrawal, while Baltimore also may be expected to request an increase. Together, they may be withdrawing as much as 1350 cfs, during a critical month, by the year 2020, from the lower Susquehanna River.

In summary, the maximum consumptive losses and interbasin transfers averaged for a critical month for three projected future years are listed in the following table.

TABLE 8

LOSSES OF WATER AT MOUTH OF SUSQUEHANNA RIVER
FOR A CRITICAL SUMMER MONTH IN FUTURE YEARS

Category of Loss	1980	2000	2020
Thermal power generation	130*	350	820
Municipal and industrial	450	750	1200
Irrigation consumption	310	510	670
Interbasin transfers	360	830	1350
Totals	1250	2440	4040

*All flows in cfs.

Below the mouth of the Susquehanna River, the Chesapeake and Delaware Canal, which links the upper Chesapeake Bay with Delaware Bay, is presently being enlarged from a 27 foot depth and a 250 foot bottom width to a 35 foot depth and 450 foot bottom width. Estimates of the daily net movement of water eastward through the canal vary, but generally fall within the range of 700 - 1,000 cfs at present, with a projected increase to 2,200 - 2,700 cfs when enlarged. The increase in net outflow through the C & D Canal, and the Susquehanna's future fresh water inflow will affect the salinity distribution in the upper Chesapeake estuary. The relationship is not simple; the salinity in a given area at a specified time, due to the storage effect of the upper Bay, will depend not only on the current flows, but on the flow history for the previous months and on the losses through the C & D Canal. These relationships cannot be modeled adequately with any device presently available, although the physical model of the Chesapeake Bay, authorized in 1965 by the Congress for construction, will provide a major advance in technological capability. (See Appendix B, Maryland Report, for a more detailed examination of the estuarine requirements.)

Analysis of Basin-wide Systems

The flow regimen of the Susquehanna River at its mouth is of particular concern since the volume and seasonal change of fresh water inflow into the upper Chesapeake Bay is a primary factor affecting its dynamic ecological patterns. Accordingly, a series of detailed basin-wide analytical simulation studies began as the Susquehanna Prospectus was being formulated to meet in-Basin needs. These simulations were intended to: (1) verify and improve the effectiveness of the Prospectus (and later the Coordinating Committee Plan) in meeting flow requirements within the Basin, including the lower Susquehanna River, and (2) measure the impact on the future flow regimen at the mouth of the Susquehanna River of the cumulative losses and diversions, both with and without the range of potential effects of the Prospectus. These analyses* are summarized in Attachment 6 (Chapter XI) for the Coordinating Committee Plan that emerged from the Prospectus following public discussions.

The simulation studies showed that the effect of the projected consumptive losses and diversions could become a serious problem in managing the water resources of the Susquehanna Basin and the Chesapeake Bay during extended low flow periods. The Early Action Plan would meet all in-Basin low flow requirements through the year 1980 without significant impact on the flow regimen of the Susquehanna River at its mouth. The incidental additions to low flow would offset the anticipated consumptive losses during low flow months. Beyond 1980, the Plan cannot keep pace with the consumptive losses and diversions as an incidental effect of meeting requirements in the upstream areas. The amount of fresh water reaching the upper Chesapeake Bay estuary would be progressively reduced, eventually reaching crisis conditions during a repeat of the drought of either the early 1930's or the mid 1960's.

*The complete results of the analyses (computer print-out sheets) are on file in the office of The Baltimore District, Corps of Engineers, Federal Office Building, Baltimore, Maryland.

The broad choices presented by the long range problem of projected flow depletions can be summarized as: (1) Prevent significant increases beyond 1980 in the overall depletion of low streamflows by close regulation of consumptive withdrawals, by substitution of non-consumptive processes in industry and electric power production, and by prevention of further significant diversions of flow out of the Basin; (2) Augment low streamflows to compensate adequately for the cumulative losses; and (3) Do little or nothing to regulate either withdrawals or streamflows. This last choice would, in effect, be a choice to ignore any significant relationship between the Chesapeake Bay and the Susquehanna River.

Examination of the "control" choice indicates that it may well be possible, at a cost, to reduce the projected flow depletions by close regulation of the Basin's streams. The projections already assume a certain degree of reduction in consumptive losses by process improvements, but they cannot be considered the minimum losses. The cost of the close regulation required, of non-use during low flow conditions (opportunity cost) and of process substitutions cannot now be readily estimated for comparison with the other choices.

The "compensation" choice involves storing water in major multiple purpose reservoir projects during surplus periods for release when needed during the low flow months. Preferably, this would be accomplished at locations that can serve points of need in addition to the lower Susquehanna River and the upper Chesapeake Bay. For the lower River or the Bay requirements, however, the closest accessible storage would be the most effectively used. To meet the projected losses, this choice would not require additional storage beyond the amount contained in the year 2020 Prospectus, as shown by the simulation analyses based on operating all reservoir projects for <u>both</u> upstream and lower River needs. The main cost involved would be the loss of some recreation benefits at the reservoir projects during the years of greatest use of storage for low flow augmentation.

The "do nothing" choice to apply no regulation of either withdrawals from or additions to low streamflow could have a doubly negative impact. The depletions and diversions could <u>exceed</u> the projected amounts, and the ecological balance of the Chesapeake Bay could suffer serious disruption of estuarine habitat upon which valuable fishery and waterfowl species critically depend.

Of the three possible choices, the optimum would probably be a combination of a reasonable degree of regulation of withdrawal and use of streamflows (at least to keep the increase in losses under control) and adequate low flow augmentation to compensate for the losses. While the "critical" decision appears to be one that can be deferred for a number of years, it must be approached now to be able to keep the options open 10 to 20 years from now. This indicates the need for reasonably broad regulatory authority at the State and interstate level at an early date to cover the entire Susquehanna Basin without divorcing it from the Chesapeake Bay; it also indicates the need to protect the more viable alternative reservoir sites that could serve the downstream requirements beyond 1980.

The Basin simulation studies for the year 2020 indicated that the Plan contains considerable flexibility to manage the low flow requirements for both in-Basin needs and the Chesapeake Bay. In addition, a number of major alternative storage sites were identified but are not included in the Plan. The reservoir projects in the Plan that could most readily be used for both local (upstream) and downstream flow regulation purposes are East Guilford (site 115) and Conewago (site 10). The Raystown Reservoir, assumed completed, by adjusting its regulation schedule after 1980, could also better serve the lower Main Stem as well as the Juniata River. All other sites in the Plan which reserve conservation storage to purposes other than low flow augmentation could also contribute to downstream requirements, but to a less effective extent.

Selection of the optimum year 2000 and year 2020 projects and regulation schedules must wait for improved understanding of the relationship of the Susquehanna River to the ecological patterns of the Chesapeake Bay. The presently authorized hydraulic model of the Bay, and associated resource studies, should yield part of the information that will permit detailed analyses of alternatives to protect the water resource values of both the Bay and the River.

CHAPTER X - PUBLIC INFLUENCE IN PLANNING DECISIONS

A. LOCAL PLANNING MEETINGS

Following the December 1968 meeting of the Susquehanna Coordinating Committee, the Workshop members prepared data for and attended the series of local planning meetings described in Appendix A. The Workshop members were designated to lead the discussion groups or to participate as professional advisors on such subjects as water supply, water quality, recreation and fish and wildlife, flood control and land management, business and industry, and municipal governments. In these meetings, the Workshop members discussed the needs and problems, and the alternative solutions, as they related to the location of the meeting. Much of the judgment that was incorporated into the plan formulation process was explained, and the local area participants were given an opportunity to comment on the process as well as on alternative possibilities and the specific items in the Prospectus.

The meetings were held at Bel Air, Maryland; Harrisburg, Altoona, Emporium, Lewisburg, Scranton, Wellsboro, and Towanda, Pennsylvania; and at Corning, Binghamton, Oneonta, and Cortland, New York. Each local planning meeting concentrated on the area of immediate concern - those counties in the vicinity of the meeting.

Following the local planning meetings in Maryland and Pennsylvania, the Workshop met at the end of February 1969 to consider changes in the Prospectus affecting those two States. (Changes for New York would be incorporated later.)

There was considerable discussion at this Workshop meeting on whether the Plan Formulation Workshop should recommend changes in the Prospectus related primarily to implementability, or to continue to base recommendations primarily on the needs and available solutions. The Workshop had been instructed that they were free to recommend to the Coordinating Committee that they restore a number of originally recommend measures deleted during the December meeting of the Committee. Further, the Workshop need not adhere to recommending to the Coordinating Committee only those measures that at this time may appear to be politically acceptable. They should use their collective professional judgment in their recommendations without rigid constraint due to present policies and attitudes. (The Workshop was concerned, for example, that the Prospectus did not meet the projected early action recreation needs.) Since the Coordinating Committee had debated their changes in the Prospectus at some length, the Workshop agreed to the decisions made by the Committee. The Workshop task, therefore, would end with completion of the local planning meetings.

There were a number of suggested changes to the Prospectus developed by the Workshop during the February meeting. Many of these changes affected the stream recreation categories and the time phasing of structural measures. A number of low in-channel dams to create recreational water surface were added, based on the analysis and recommendations of the Commonwealth of Pennsylvania.

The Workshop also discussed their interpretation of the role of the stream category system. It was intended as an inventory of potential to guide stream management for recreational use, in essentially a free-flowing condition or with low dams, in an effort to retain their more important aesthetic, scenic, and historical values. Development of industry and transportation should be compatible with the stream category potential for recreational and fishing use, as well as the flood threat of each stream. (The Workshop noted that the stream category system was well received at the local planning meetings.)

The Workshop participated in the local planning meetings in New York during the first three weeks of March 1969. Due to the press of time, the full Workshop did not meet before the April 1-2, 1969 meeting of the Coordinating Committee. The February 1969 meeting, therefore, was the last session of the full Plan Formulation Workshop. The Coordinating Committee had adopted a Prospectus for public review and would be called on to decide on a Coordinating Committee Plan in July, following the Public Forums. The final decision-making role in preparing a comprehensive plan had fully shifted to the Coordinating Committee as of their April 1969 meeting.

The changes in the Susquehanna Prospectus, from the version adopted by the Coordinating Committee in December of 1968, are listed in Chapter XI, Attachment 5. These constitute all changes made in the Prospectus following the series of local planning meetings, and indicate a response to the broadening involvement of the planning staff with concerned citizens, as well as the increased role of the Coordinating Committee members in reviewing the specific selections contained in the Prospectus.

B. PUBLIC FORUMS AND COORDINATING COMMITTEE PLAN

By the end of their April 1969 meeting, the Coordinating Committee had agreed on a modified Prospectus for the water and related land resources development of the Susquehanna River Basin. The Prospectus, along with a number of "critical" decisions of local interest, would be presented to the general public at nine Public Forum meetings throughout the Basin before deciding on the plan to be recommended in the final report.

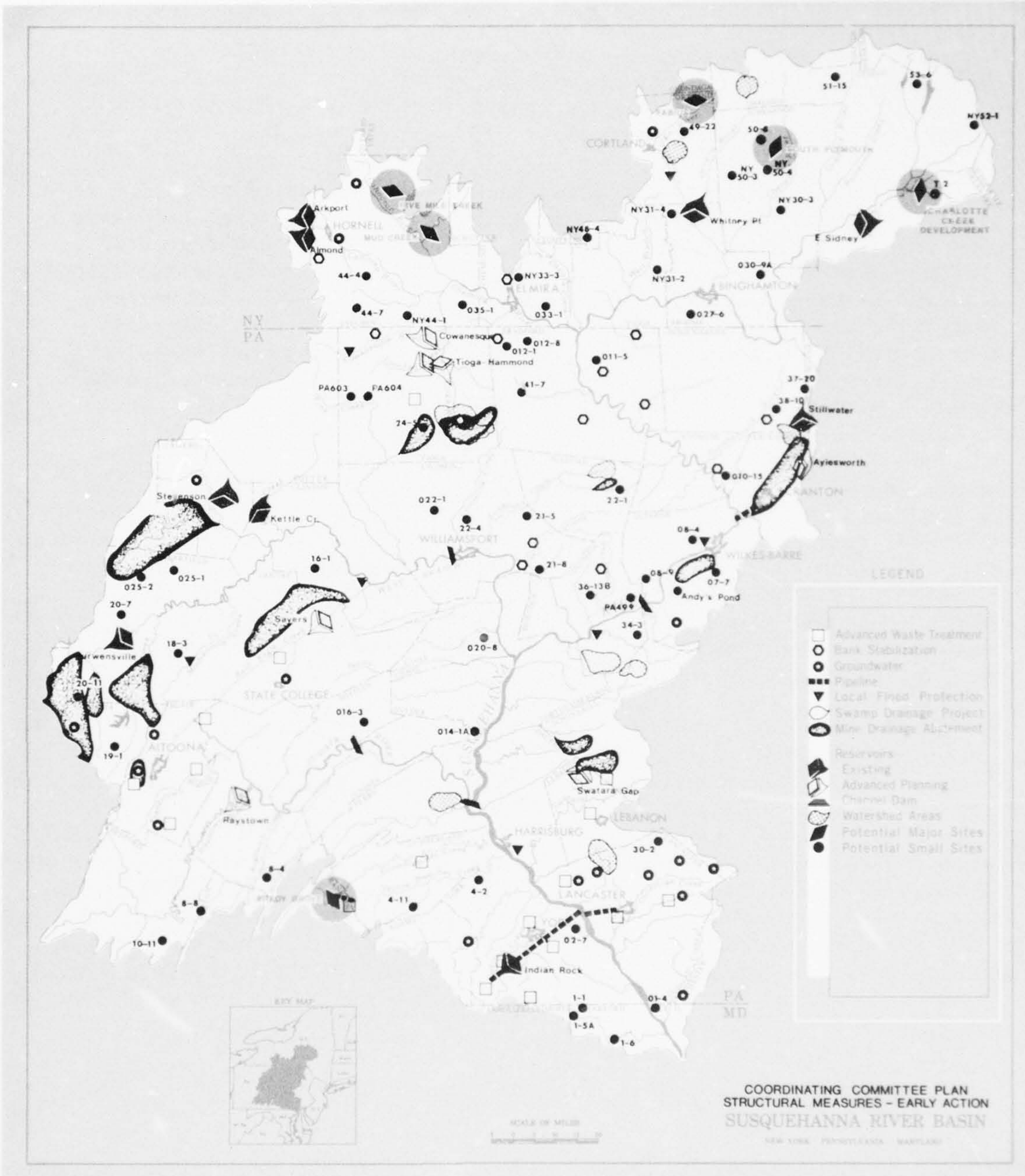
COORDINATING COMMITTEE PLAN
STRUCTURAL MEASURES - EARLY ACTION
SUSQUEHANNA RIVER BASIN
LEGEND
Advanced Waste Treatment
Bank Stabilization
Groundwater
Pipeline
Local Flood Protection
Swamp Drainage Project
Mine Drainage Abatement
Reservoirs
Existing
Advanced Planning
Channel Dam
Watershed Areas
Potential Major Sites
Potential Small Sites
NY
PA
MD
Arkport
Almond
Whitney Pt
E Sidney
Charlotte Creek Development
Cowanesque
Tioga-Hammond
Stillwater
Ayiesworth
Stevenson
Kettle Cr.
Sayers
Andy's Pond
Raystown
Swatara Gap
Indian Rock
Cortland
Binghamton
Williamsport
Wilkes-Barre
State College
Altoona
Harrisburg
Lebanon
Lancaster

Figure 14

AD-A043 888 SUSQUEHANNA RIVER BASIN STUDY COORDINATING COMMITTEE F/G 8/6
SUSQUEHANNA RIVER BASIN STUDY, SUPPLEMENT A, PLAN FORMULATION.(U)
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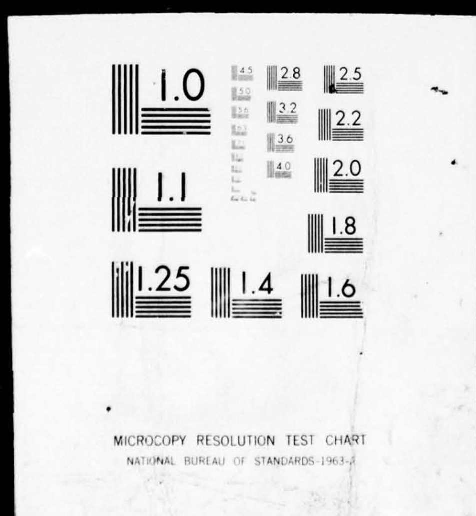
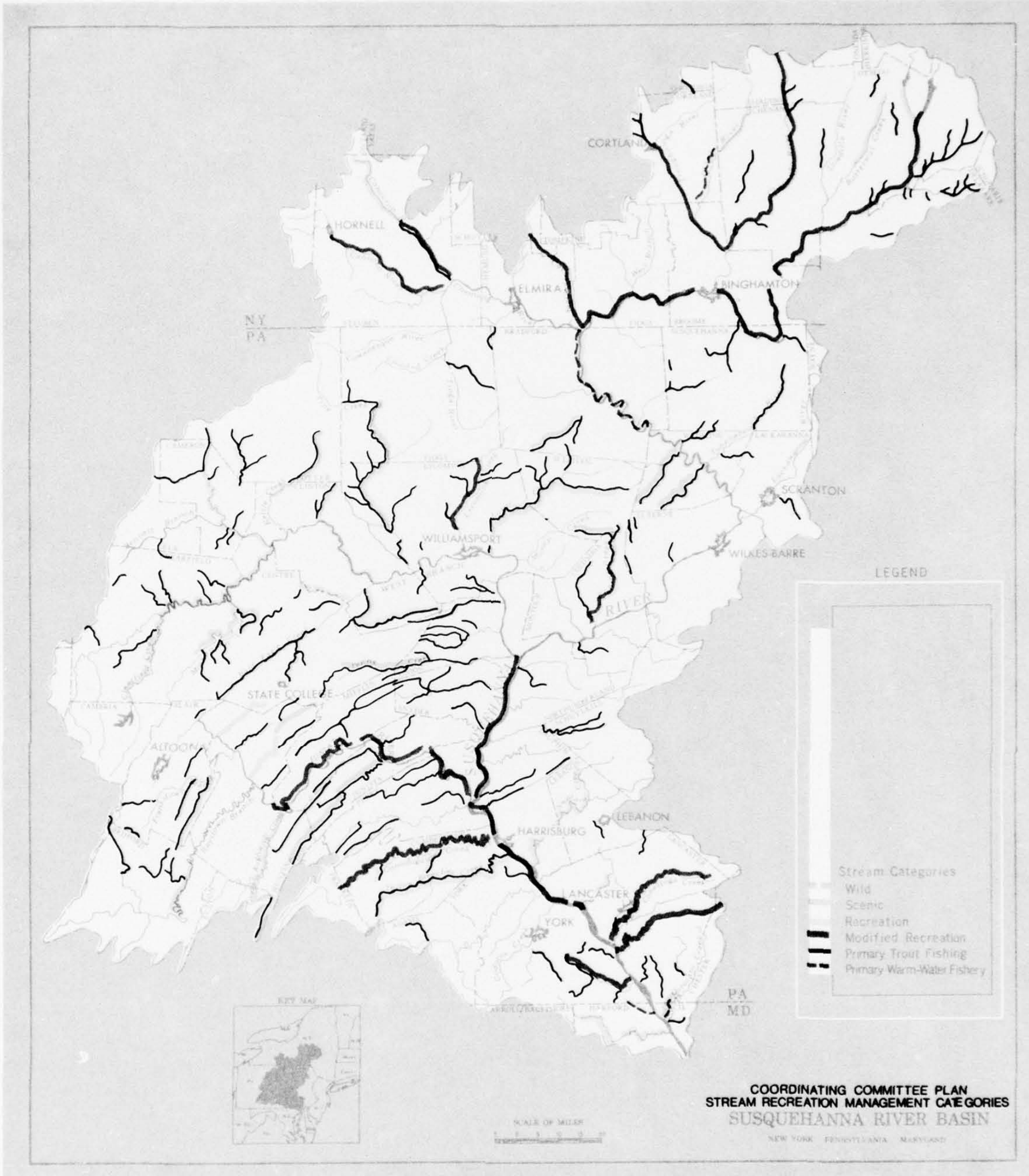


The Forums were held between May 27 and June 23 at Wilkes-Barre, Towanda, Harrisburg, Huntingdon, and Lock Haven, Pennsylvania; Oneonta, Binghamton, and Elmira, New York; and Baltimore, Maryland. (See Appendix A for a description of the Forums as part of the public information program.) Many of the Workshop participants and key Coordinating Committee members attended to respond to public questions on the Prospectus and its alternatives, and to answer the more detailed questions from individuals following the meetings.

The Forum meeting at each location was accompanied by publicity by the news media before and after the meeting itself. The critical elements of the Prospectus, for each area of the Basin, were given a degree of publicity with the intent of developing local public knowledge and response to assist in the decisions of the Coordinating Committee. The meetings themselves, and the associated publicity by the news media, generated a range of public responses that continued well after the meeting dates. Many of these responses were requests for additional information, but some offered specific comments on Prospectus measures.

The Coordinating Committee met at the end of July 1969 to decide on changes in the Susquehanna Prospectus as a result of the Public Forums. The Committee considered each recommendation for change in the Prospectus as it was presented at the Forums. (The changes agreed to by the Committee during the July 1969 meetings are also shown in Attachment 5.) The resulting plan then constituted the Coordinating Committee Plan for the Basin through the year 2020. The figures on the following pages represent the projects and programs comprising the Coordinating Committee Plan for three future points in time-- the years 1980, 2000, and 2020.

Figure 14 illustrates the locations of the project recommendations of the Coordinating Committee for early action, those measures needed by the year 1980. When complemented by the stream and land management measures shown on Figures 15 and 16, together they constitute the recommended Early Action Plan of the Coordinating Committee for the Susquehanna River Basin. Figures 17 and 18 show the structural elements identified for later action, the years 2000 and 2020, respectively. While not part of the Early Action Plan, they do constitute the apparent best solutions required after 1980 to water and related land resource needs. All measures working together make up the total comprehensive plan for the Basin through the year 2020.



CORTLAND
HORNELL
ELMIRA
BINGHAMTON
NY
PA
SCRANTON
WILLIAMSPORT
WILKES-BARRE
RIVER
STATE COLLEGE
ALTOONA
LEBANON
HARRISBURG
LANCASTER
YORK
PA
MD
LEGEND
Stream Categories
Wild
Scenic
Recreation
Modified Recreation
Primary Trout Fishing
Primary Warm-Water Fishery
COORDINATING COMMITTEE PLAN
STREAM RECREATION MANAGEMENT CATEGORIES
SUSQUEHANNA RIVER BASIN
NEW YORK PENNSYLVANIA MARYLAND

Figure 15

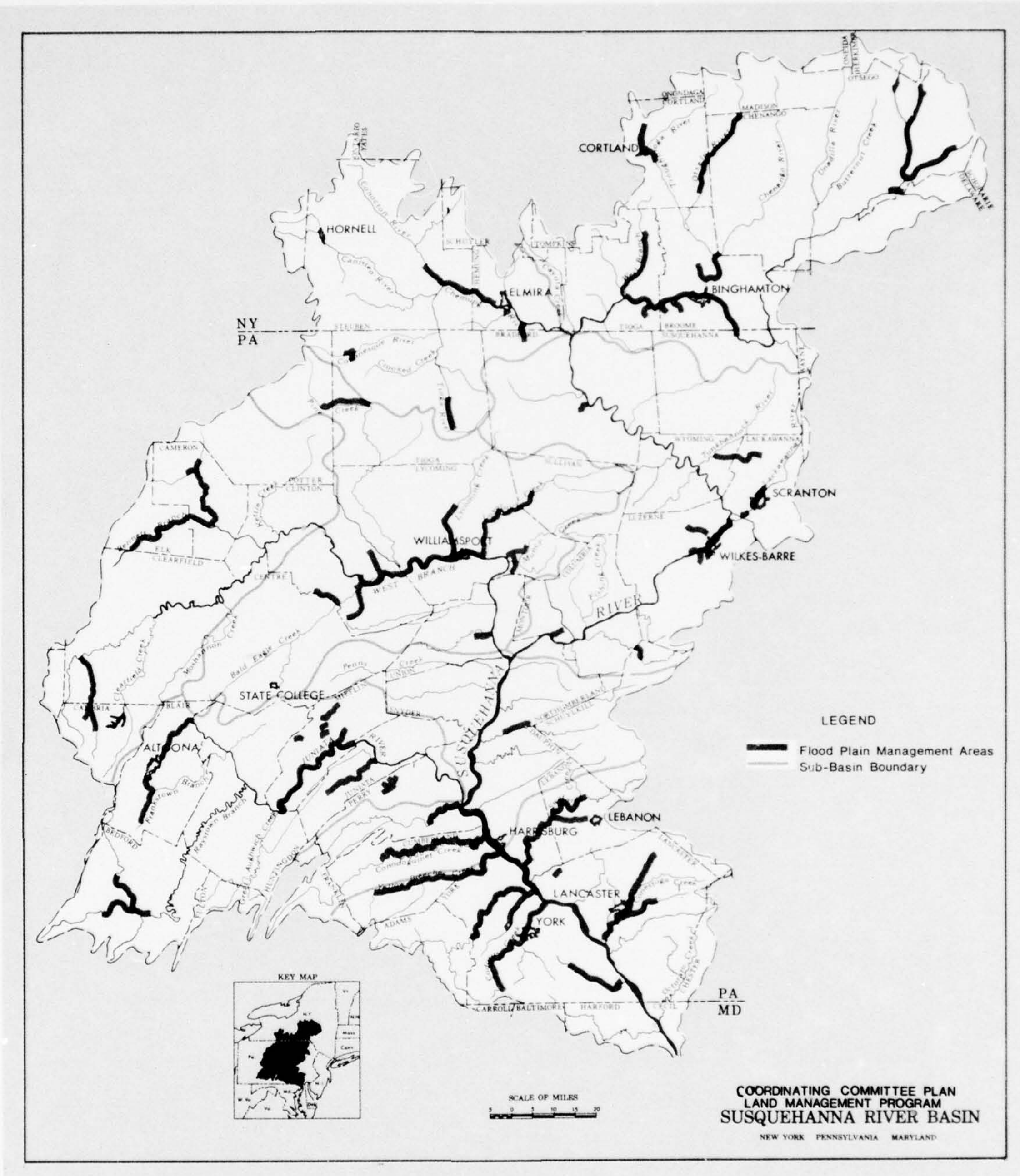
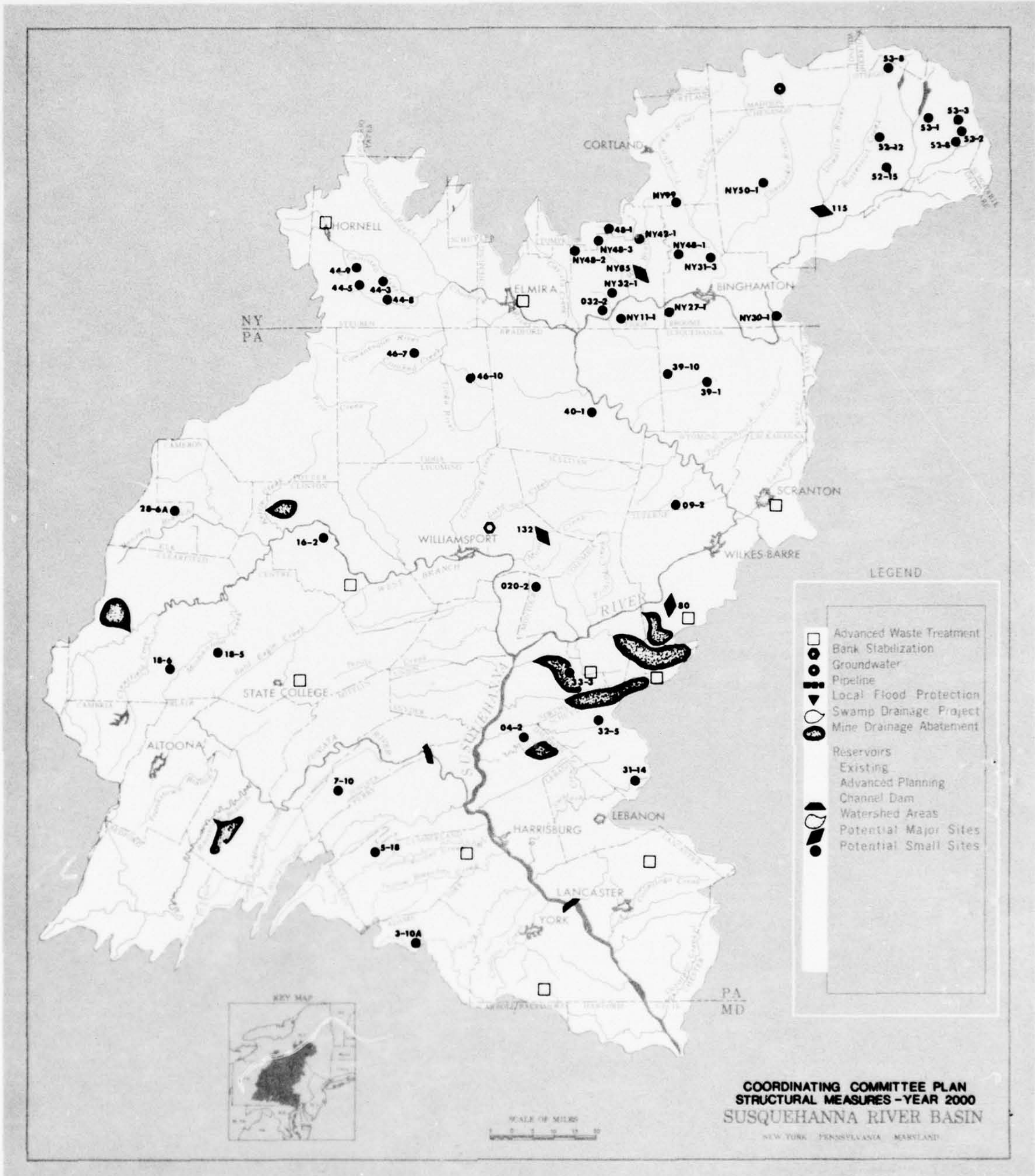
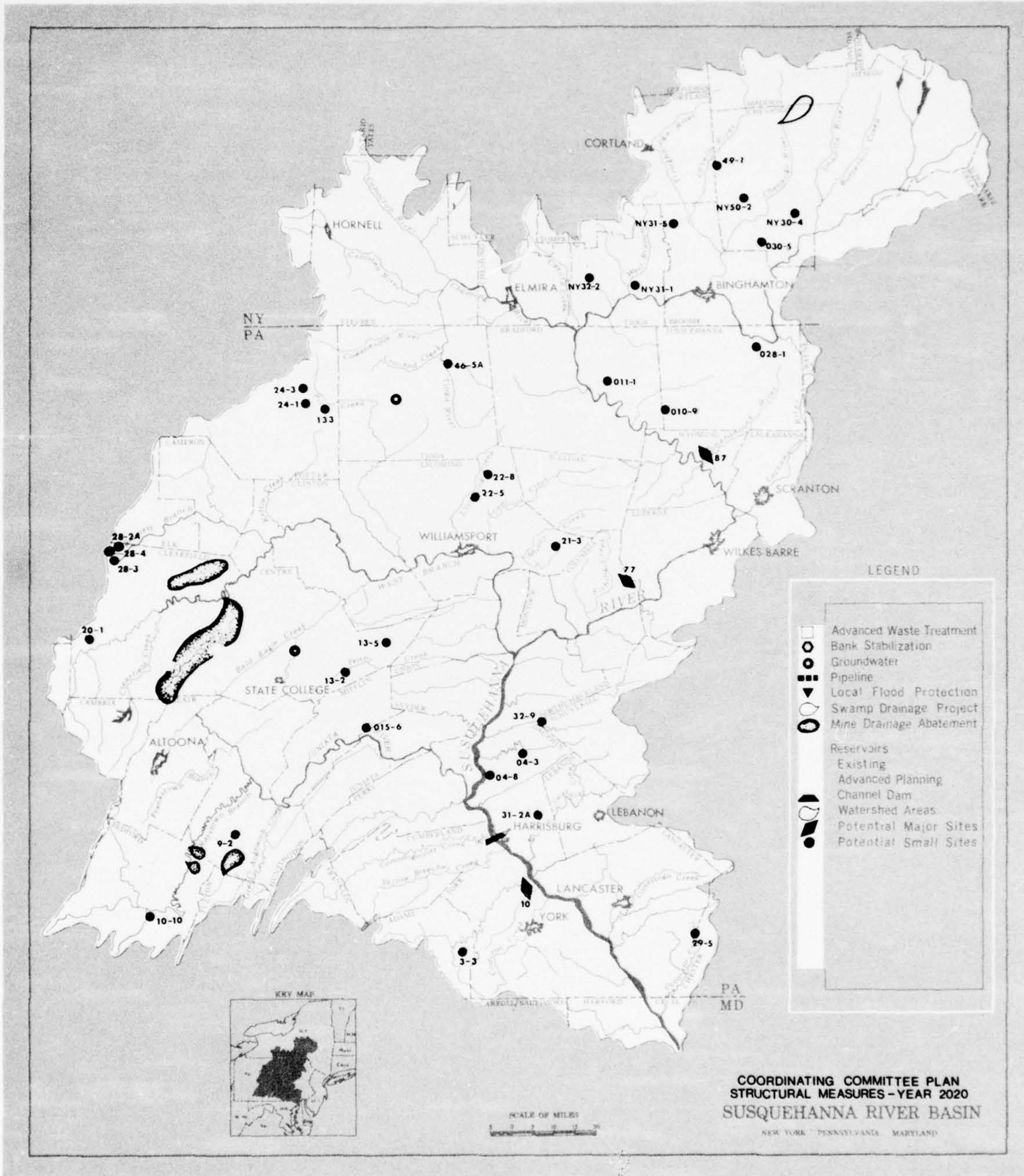

CORTLAND
HORNELL
ELMIRA
BINGHAMTON
NY
PA
SCRANTON
WILLIAMSPORT
WILKES-BARRE
WEST BRANCH
RIVER
SUSQUEHANNA
STATE COLLEGE
ALTOONA
LEGEND
Flood Plain Management Areas
Sub-Basin Boundary
LEBANON
HARRISBURG
LANCASTER
YORK
PA
MD
KEY MAP
SCALE OF MILES
COORDINATING COMMITTEE PLAN
LAND MANAGEMENT PROGRAM
SUSQUEHANNA RIVER BASIN
NEW YORK PENNSYLVANIA MARYLAND

Figure 16



LEGEND
Advanced Waste Treatment
Bank Stabilization
Groundwater
Pipeline
Local Flood Protection
Swamp Drainage Project
Mine Drainage Abatement
Reservoirs
Existing
Advanced Planning
Channel Dam
Watershed Areas
Potential Major Sites
Potential Small Sites
CORTLAND
HORNELL
ELMIRA
BINGHAMTON
SCRANTON
WILKES-BARRE
WILLIAMSPORT
STATE COLLEGE
ALTOONA
HARRISBURG
LEBANON
LANCASTER
YORK
NY
PA
MD
COORDINATING COMMITTEE PLAN
STRUCTURAL MEASURES-YEAR 2000
SUSQUEHANNA RIVER BASIN

Figure 17



CORTLAND
HORNELL
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BINGHAMTON
NY
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SCRANTON
WILLIAMSPORT
WILKES BARRE
STATE COLLEGE
ALTOONA
HARRISBURG
LEBANON
LANCASTER
YORK
PA
MD
49-1
NY50-2
NY30-4
NY31-5
030-5
NY32-2
NY31-1
028-1
46-5A
011-1
010-9
24-3
24-1
133
87
22-8
22-5
21-3
77
28-2A
28-4
28-3
20-1
13-5
13-2
32-9
015-6
04-3
04-8
31-2A
9-2
10
10-10
3-3
29-5
LEGEND
Advanced Waste Treatment
Bank Stabilization
Groundwater
Pipeline
Local Flood Protection
Swamp Drainage Project
Mine Drainage Abatement
Reservoirs
Existing
Advanced Planning
Channel Dam
Watershed Areas
Potential Major Sites
Potential Small Sites
KEY MAP
SCALE OF MILES
COORDINATING COMMITTEE PLAN
STRUCTURAL MEASURES - YEAR 2020
SUSQUEHANNA RIVER BASIN
NEW YORK PENNSYLVANIA MARYLAND

Figure 18

The Plan Formulation Summary Tables in Chapter XI, Attachment 3, summarize the comparative selections of the specific structural measures: reservoirs, advanced waste treatment plans, ground water wellfields, local flood protection projects, and pipelines. The measures dated "1980" in the column "Reasons for Selection or Rejection for Coordinating Committee Plan" correspond to Figure 14 for individual projects for the early action period. The measures dated "2000" and "2020" in the same column are those that appear to the Coordinating Committee at this time to be the best solutions to the longer range needs, and correspond to Figures 17 and 18 as indicated by the legend. The features of the Coordinating Committee Plan which are not shown on Figures 14 - 18 or included in the Summary Tables are the secondary waste treatment plant locations, the data collection program, and the special studies recommended.

The Coordinating Committee Plan reflects a blending of three objectives -- economic efficiency, regional development, and environmental quality -- as they have been discussed in this Supplement. All of the recommendations of the Coordinating Committee are discussed in Supplement B, Program Summary. The reader is referred to that Supplement for a description of the Plan and recommendations of the Committee on implementation, additional study, and changes in law and policy required. Supplement B also contains the analysis of the adequacy of the Plan and indication of needs foregone. More detailed description of individual projects and management programs in the Plan is contained in Appendices K(2) and K(3), respectively.

CHAPTER XI - ATTACHMENTS

WATER RESOURCE REQUIREMENTS TABLES

Attachment 1 is a summary tabulation of data on each of the water and related land resource requirements for each sub-basin in the Susquehanna River Basin. The order of presentation implies no priority, but does parallel both Chapter II of this Supplement and the explanation that follows.

A. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

The water supply service areas by sub-basin are listed with the statistically predicted low streamflow for a 7-day period expected to occur once in 25 years (Appendix D). For each service area, the total demand estimates for three future time points are also shown (from Appendix F). A comparison of demand to surface supply would indicate whether a surface water shortage is likely to occur. The surface must be adjusted for the effects of upstream consumptive losses, diversions, and additions. The demand must also be reduced by the amount of ground water use, provided that withdrawals from a ground water aquifer do not immediately deplete the natural streamflow, as would be the case when wells near the streambed take water from underlying gravels.

B. AGRICULTURAL WATER SUPPLY

Estimated irrigation requirements are next listed for the entire sub-basin. The figures represent the projected total withdrawal from natural streamflow from the drainage area upstream from the mouth of the sub-basin. The major effect is one of competition with downstream users for surface water supplies during periods of drought scarcity. Irrigation requirements are explained in further detail in Appendix F, including estimates, in addition, for key points within each sub-basin.

C. GENERAL OUTDOOR RECREATION

The two measurements of projected recreation demand tabulated are in terms of water-oriented recreation days and boating acreage, both restricted and unrestricted* (see Glossary). These are compared to the recreation resource supply adjusted to 1980 to include recreation development already committed for completion by 1980. Appendix G, Part 1, is the source of supply and demand data.

* Unrestricted boating demand is shown for capacities of both (2-1/2 acres per boat and 5 acres per boat)

The projected recreation demands cannot be readily distributed below the sub-basin level, even though some preferences of location do exist. Further, there is a certain amount of mobility of interchange of the demand between adjacent sub-basins, allowing considerable flexibility in meeting the demands allocated to one sub-basin within another.

D. FISH AND WILDLIFE

The supply and demand data for fishing are provided in a similar format as for the general recreation figures preceding. The comments on mobility of demand also apply. Supply and demand data are provided in detail in Appendix G, Part 2.

E. WATER QUALITY MANAGEMENT

One of several critical water quality parameters is the level of dissolved oxygen downstream from disposal points for treated wastes generated by municipal and industrial uses. Estimates of the amount of streamflow required to meet a standard of 5.0 milligrams per liter (mg/l) of dissolved oxygen (average for a critical month) are projected to the year 2020. These estimates assume a secondary level of treatment, 85 percent removal of biochemical oxygen demand (BOD), that can be considered reasonably adequate for normal streamflow conditions. Contracted with the demand are the statistical low streamflows downstream from the locations listed. These can be expected to occur during the corresponding month once in a 25-year period. Where the projected flow requirement exceeds the statistical streamflow, adjusted for upstream losses and additions, a water quality problem is likely to occur. Appendix F provides the basic data from which the selected critical locations are listed in this Attachment.

F. COAL MINE DRAINAGE POLLUTION ABATEMENT

Most sub-basins have some degree of pollution by drainage from coal mines of waters laden with acid and undesirable minerals in solution. Abandoned deep and strip mines are the major cause of concern. The problem watersheds are listed with estimates of the average daily loading of acid and iron in solution as an indication of the relative severity of the pollution source. Appendix F is the source of information.

G. FLOOD DAMAGE REDUCTION

A breakdown of the total average annual flood damages expected by tributary and major community is provided for each sub-basin. These estimates have been adjusted for the effect of anticipated increases in flood damages into the future, using current price levels, as described in Appendix E. The effects of the existing and programmed flood control structures summarized in Chapter II have also been taken into account, greatly reducing the potential for recurring damages that would otherwise occur along rural reaches as well as at major communities.

H. LAND TREATMENT

The tabulations show the total area requiring land treatment in each sub-basin, including the acreage proposed for accelerated treatment upstream from the selected reservoirs. Detailed information on the nature and extent of the problem is contained in Appendix J. The requirements for land treatment were not included in the systematic analysis of water resource problems as a variable, except as they relate to reservoir selections.

I. STREAMBANK STABILIZATION

The more important locations where streambank stabilization appeared to be required are listed, while additional information can be found in Appendix K(2). This problem was treated separately in plan formulation since it did not require inclusion in the systematic analysis of interrelated water problems.

J. ELECTRIC POWER PRODUCTION

The requirements for production of electric power are outlined in Appendix H. No information on the problem and its relationship to individual sub-basins is included in Attachment 1 since power production and demand was not considered to be sensitive to sub-basin divisions. Development for hydroelectric power at any location in the Basin must compete economically with power from all other sources, including fossil-fuel and nuclear energy plants in the same region.

K. COMMERCIAL NAVIGATION

Early studies of the competitive demand for development of commercial navigation facilities showed little, if any, need for consideration in analysis of the pattern of the Basin's water-related problems. No information is tabulated in this Attachment; summary of the most recent review of commerical navigation potential is included in an Attachment to Appendix C.

L. CHESAPEAKE BAY REQUIREMENTS

The ecological balance of the upper Chesapeake Bay is dominated by the seasonal fresh water inflow pattern of the Susquehanna River. A significant change in the pattern of the river flows, established over the centuries of the Bay's evolution, could cause a corresponding change in the dynamic balance of the Bay's ecology. The limited extent of knowledge of this potentially critical problem is summarized in Appendix B, Maryland Report.

SUSQUEHANNA RIVER SUB-BASINS Figure 19

TABLE 9

WATER RESOURCE REQUIREMENTS TABLES

SUB-BASIN I

SUSQUEHANNA RIVER BASIN - UPSTREAM FROM ATHENS, PA.

A. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Service Area	Surface Flow cfs (low 7 days in 25 years)	Year	Estimated Population Served (1,000's)	Estimated M & I Water Use cfs
Oneonta, N.Y.	48.0	1980	23.0	6.1
		2000	34.6	10.3
		2020	56.0	19.1
Cortland, N.Y.	23.7	1980	40.5	19.5
		2000	65.6	40.4
		2020	113.0	71.4
Hamilton, N.Y.	4.0	1980	10.0	1.8
		2000	19.0	4.7
		2020	37.0	11.9
Sidney, N.Y.	76.2	1980	15.8	9.7
		2000	36.1	23.1
		2020	83.0	48.6
Binghamton, N.Y.	272.3	1980	275.0	102.7
		2000	454.0	213.5
		2020	785.0	373.6
Norwich, N.Y.	23.5	1980	13.4	5.9
		2000	21.2	11.7
		2020	36.0	20.8

B. AGRICULTURAL WATER SUPPLY

Projected Irrigation Demand

		1980	2000	2020
Estimated Maximum Withdrawal Rate	cfs	74	147	169
Seasonal Volume Removal in Dry Years	Ac. Ft.	8340	16,820	20,040

C. GENERAL OUTDOOR RECREATION

Seasonal Recreation Demand Compared with 1980 Supply

		1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Water Oriented Recreation-Days		2803	6515	11,788	18,898
Restricted Boating Acreage	Developed	210			
	Demand (1 ac/boat)		2730	4,750	7,340
Unrestricted Boating Acreage	Developed	2440			
	Demand (2½ ac/boat)		3360	5,850	9,040
	Demand (5 ac/boat)		6720	11,690	18,090

D. FISH AND WILDLIFE

Projected Fishing Demand Compared with 1980 Supply

	1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Fisherman-Days	2169	1576	2645	3928

E. WATER QUALITY MANAGEMENT

Flows Needed to Maintain 5.0 mg/l Dissolved Oxygen

Location	Surface Flow cfs (low August in 50 years)	Target Year	Projected Effluent Flow cfs	Flow Needed To Maintain Standard cfs
Norwich, N.Y.	25.9	1980	2.6	14
		2000	4.8	27
		2020	9.1	49
Cortland, N.Y.	27.0	1980	17.8	47
		2000	33.2	93
		2020	60.3	148
Endicott, N.Y.	301.0	1980	20.6	185
		2000	40.6	380
		2020	80.8	690

F. COAL MINE DRAINAGE POLLUTION ABATEMENT

(No problem in Sub-basin I)

G. FLOOD DAMAGE REDUCTION

Reach	Average Annual Damages $1,000
Susquehanna River - Oneonta, N.Y., to Unadilla River	$ 311
Susquehanna River - Unadilla River to Chenango River	627
Susquehanna River - Chenango River to Sayre, Pa.	993
Unadilla River - New Berlin, N.Y., to Susquehanna River	114
Tioughnioga River - Cortland, N.Y., to Chenango River	671

G. FLOOD DAMAGE REDUCTION (CONT'D)

Reach	Average Annual Damages $1,000
Chenango River - Norwich, N.Y., to Susquehanna River	619
Upstream Watersheds	531
Total	$3,866

H. LAND TREATMENT

Total area needing treatment is 1,773,341 acres of which 21,612 acres are proposed for accelerated land treatment on forest land, 2,796 acres on cropland, and 3,046 acres on pasture land and upstream from recommended reservoirs.

I. STREAMBANK STABILIZATION

Wappasening Creek, just below New York-Pennsylvania border

SUB-BASIN II

CHEMUNG RIVER BASIN

A. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Service Area	Surface Flow cfs (low 7 days in 25 years)	Year	Estimated Population Served (1,000's)	Estimated M & I Water Use cfs
Bath, N.Y.	9.4	1980	13.2	4.3
		2000	29.6	10.0
		2020	64.0	20.7
Corning, N.Y.	60.4	1980	44.7	29.4
		2000	81.0	46.1
		2020	149.0	74.4
Elmira, N.Y.	64.9	1980	141.8	86.4
		2000	248.2	166.6
		2020	441.0	266.9
Hornell, N.Y.	3.1	1980	22.8	6.1
		2000	26.9	8.6
		2020	34.0	12.3

B. AGRICULTURAL WATER SUPPLY

Projected Irrigation Demand

		1980	2000	2020
Estimated Maximum Withdrawal Rate	cfs	6.5	9.5	11.0
Estimated Volume Removal in Dry Years	Ac. Ft.	720.0	1,050.0	1,190.0

C. GENERAL OUTDOOR RECREATION

Seasonal Recreation Demand Compared with 1980 Supply

		1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Water Oriented Recreation-Days		857	2601	4646	7577
Restricted Boating Acreage	Developed	200			
	Demand (1 ac/boat)		1090	1870	2940
Unrestricted Boating Acreage	Developed	0			
	Demand ($2\frac{1}{2}$ ac/boat)		1340	2300	3620
	Demand (5 ac/boat)		2680	4600	7250

D. FISH AND WILDLIFE

Projected Fishing Demand Compared with 1980 Supply

	1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Fisherman-Days	484	529	813	1276

E. WATER QUALITY MANAGEMENT

Flows Needed to Maintain 5.0 mg/1 Dissolved Oxygen

Location	Surface Flow cfs (low August in 50 years)	Target Year	Projected Effluent Flow cfs	Flow Needed To Maintain Standard cfs
Hornell, N.Y.	6.2	1980	4.5	13.3
		2000	5.7	17.8
		2020	8.1	23.4
Bath, N.Y.	12.4	1980	2.9	6.5
		2000	6.4	12.4
		2020	14.0	23.5

E. WATER QUALITY MANAGEMENT (CONT'D)

Flows Needed to Maintain 5.0 mg/l Dissolved Oxygen

Location	Surface Flow cfs (low August in 50 years)	Target Year	Projected Effluent Flow cfs	Flow Needed To Maintain Standard cfs
Corning, N.Y.	80.4	1980	12.6	60
		2000	23.3	101
		2020	41.9	160
Elmira, N.Y.	86.4	1980	33.9	165
		2000	64.5	312
		2020	116.0	505

F. COAL MINE DRAINAGE POLLUTION ABATEMENT

Watershed	Estimated Average Daily Loading		
	Flow cfs	Acid tons	Iron tons
Tioga River	16.3	20	3.6

G. FLOOD DAMAGE REDUCTION

Reach	Average Annual Damages $1,000
Tioga River	$ 463
Cowanesque River	327
Canisteo River	172
Cohocton River	648
Chemung River	322
Upstream Watersheds	594
Total	$2,526

H. LAND TREATMENT

Total area needing treatment is 997,545 acres. Upstream from recommended reservoirs an accelerated treatment on 2,960 acres of cropland, 2,905 acres of pasture land and 25,258 acres of forest land is needed.

I. STREAMBANK STABILIZATION

Purdy Creek in Hartsville, New York
Newtown Creek in Horseheads, New York
Cowanesque River between Westfield and Knoxville, Pennsylvania
Coal Run in Blossburg, Pennsylvania
Bentley Creek just above Pennsylvania-New York line

SUB-BASIN III

SUSQUEHANNA RIVER BASIN - ATHENS TO SUNBURY, PA.

A. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Service Area	Surface Flow cfs (low 7 days in 25 years)	Year	Estimated Population Served (1,000's)	Estimated M & I Water Use cfs
Scranton, Pa.	29.1	1980	257.5	91.8
		2000	326.3	137.7
		2020	466.0	212.3
Hazleton, Pa.	2.5	1980	78.0	18.1
		2000	103.0	27.3
		2020	154.0	46.4

B. AGRICULTURAL WATER SUPPLY

Projected Irrigation Demand

		1980	2000	2020
Estimated Maximum Withdrawal Rate	cfs	32	54	79
Estimated Volume Removal in Dry Years	Ac. Ft.	3300	5130	7510

C. GENERAL OUTDOOR RECREATION

Seasonal Recreation Demand Compared with 1980 Supply

		1980 Supply	1980	2000	2020
1000's of Water Oriented Recreation-Days		4144	6967	12,683	20,494
Restricted Boating Acreage	Developed	749			
	Demand (1 ac/boat)		2920	5,100	7,960
Unrestricted Boating Acreage	Developed	1627			
	Demand ($2\frac{1}{2}$ ac/boat)		3540	6,240	9,800
	Demand (5 ac/boat)		7180	12,580	19,600

D. FISH AND WILDLIFE

Projected Fishing Demand Compared with 1980 Supply

	1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Fisherman-Days	1188	1232	1921	3522

E. WATER QUALITY MANAGEMENT

Flows Needed to Maintain 5.0 mg/1 Dissolved Oxygen

Location	Surface Flow cfs (low August in 20 years)	Target Year	Projected Effluent Flow cfs	Flow Needed To Maintain Standard cfs
Scranton, Pa.	41	1980	36.1	109
		2000	51.5	135
		2020	81.2	189
Hazleton, Pa.	12	1980	11.6	28
		2000	18.9	43
		2020	33.3	67

F. COAL MINE DRAINAGE POLLUTION ABATEMENT

Watershed	Estimated Average Daily Loading: Flow cfs	Acid tons	Iron tons
Lackawanna River	116.7	71.5	31.4
Wyoming Valley	91.1	71.0	31.1
Nescopeck Creek	66.7	39.4	2.6
Catawissa Creek	45.3	14.0	0.4
Total	319.8	195.9	65.5

G. FLOOD DAMAGE REDUCTION

Reach	Average Annual Damages $1,000
Susquehanna River - Athens, Pa., to Lackawanna River	$ 529
Susquehanna River - Lackawanna River to West Branch	1,846
Lackawanna River	890
Upstream Watersheds	907
Total	$4,172

H. LAND TREATMENT

Total area needing treatment is 1,324,668 acres of which proposed accelerated treatment upstream from recommended reservoirs involves 21,698 acres of forest land, 1,093 acres of cropland, and 2,303 acres of pasture land.

I. STREAMBANK STABILIZATION

Wysox Creek between T571 and 187
Towanda Creek below East Canton, Pennsylvania
Wyalusing Creek 6 miles above Susquehanna River
Tunkhannock Creek, 5 miles of East Branch and 4 miles of South Branch
Fishing Creek between Grassmore and Bloomsburg, Pennsylvania

SUB-BASIN IV

WEST BRANCH, SUSQUEHANNA RIVER - UPSTREAM FROM RENOVO, PA.

A. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Service Area	Surface Flow cfs (low 7 days in 25 years)	Year	Estimated Population Served (1,000's)	Estimated M & I Water Use cfs
Barnesboro-Spangler, Pa.	2.0	1980	13.0	2.2
		2000	14.0	2.9
		2020	16.0	4.7
Philipsburg, Pa.	4.0	1980	12.0	3.9
		2000	16.0	6.1
		2020	22.0	9.6
Patton, Pa.	2.4	1980	6.0	0.6
		2000	7.0	0.8
		2020	9.0	1.1
Emporium, Pa.	3.3	1980	8.3	3.6
		2000	14.0	6.7
		2020	24.0	11.9

B. AGRICULTURAL WATER SUPPLY

Projected Irrigation Demand

		1980	2000	2020
Estimated Maximum Withdrawal Rate	cfs	3	5	7
Estimated Volume Removal in Dry Years	Ac. Ft.	300	490	690

C. GENERAL OUTDOOR RECREATION

Seasonal Recreation Demand Compared with 1980 Supply

		1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Water Oriented Recreation-Days		1815	4078	5412	9032
Restricted Boating Acreage	Developed	0			
	Demand (1 ac/boat)		1710	2180	3510
Unrestricted Boating Acreage	Developed	3712			
	Demand ($2\frac{1}{2}$ ac/boat)		2100	2680	4320
	Demand (5 ac/boat)		4200	5370	8640

D. FISH AND WILDLIFE

Projected Fishing Demand Compared with 1980 Supply

	1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Fisherman-Days	480	596	886	1549

E. WATER QUALITY MANAGEMENT

(No problem in Sub-basin IV)

F. COAL MINE DRAINAGE POLLUTION ABATEMENT

Watershed	Estimated Average Daily Loading Flow cfs	Acid tons	Iron tons
Upper West Branch	19.7	26.7	11.5
Chest Creek	7.9	4.2	1.1
Anderson Creek	3.1	3.7	0.8
Clearfield Creek	44.0	22.6	6.5
Congress Run	1.1	5.7	1.0
Deer Creek	2.2	7.7	1.2
Sandy Run	1.1	5.0	0.6
Alder Run	4.0	9.0	0.7
Moshannon Creek	146.8	67.6	38.1
Sinnemahoning Creek	10.9	16.4	2.7
Cooks Run	1.4	6.5	0.9
Kettle Creek	6.7	14.2	3.6
Total	248.9	189.3	68.7

G. FLOOD DAMAGE REDUCTION

Reach	Average Annual Damages $1,000
West Branch Susquehanna River - Curwensville Dam to Sinnemahoning Creek	$ 178
West Branch Susquehanna River - Sinnemahoning Creek to Kettle Creek	61
Sinnemahoning Creek	181
Upstream Watersheds	1,475
Total	$1,895

H. LAND TREATMENT

Total area needing treatment is 1,244,322 acres of which 1,892 acres of forest land, 209 acres of cropland and 128 acres of pasture land are upstream from recommended reservoirs and are in need of accelerated treatment.

SUB-BASIN V

WEST BRANCH, SUSQUEHANNA RIVER - RENOVO TO SUNBURY, PA.

A. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Service Area	Surface Flow cfs (low 7 days in 25 years)	Year	Estimated Population Served 1000's	Estimated M & I Water Use cfs
State College, Pa.	6.8	1980	75.0	16.[illegible]
		2000	118.0	30.0
		2020	147.0	45.7
Wellsboro, Pa.	1.4	1980	7.9	4.4
		2000	13.4	7.9
		2020	23.0	15.5
Hughesville, Pa.	1.8	1980	10.4	3.3
		2000	16.2	5.0
		2020	24.0	8.2

B. AGRICULTURAL WATER SUPPLY

Projected Irrigation Demand

		1980	2000	2020
Estimated Maximum Withdrawal Rate	cfs	57	99	138
Estimated Volume Removal in Dry Years	Ac. Ft.	5580	9480	13,240

C. GENERAL OUTDOOR RECREATION

Seasonal Recreation Demand Compared with 1980 Supply

		1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Water Oriented Recreation-Days		5121	6452	11,678	19,016
Restricted Boating Acreage	Developed	2,50			
	Demand (1 ac/boat)		2700	4,700	7,390
Unrestricted Boating Acreage	Developed	3490			
	Demand (2½ ac/boat)		3330	5,790	9,100
	Demand (5 ac/boat)		6660	11,580	18,200

D. FISH AND WILDLIFE

Projected Fishing Demand Compared with 1980 Supply

	1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Fisherman-Days	1261	1018	1494	2228

E. WATER QUALITY MANAGEMENT

Flows Needed to Maintain 5.0 mg/1 Dissolved Oxygen

Location	Surface Flow cfs (low August in 20 years)	Target Year	Projected Effluent Flow cfs	Flow Needed To Maintain Standard cfs
State College, Pa.	16.0	1980	6.2	37
		2000	8.1	88
		2020	11.0	132
Bellefonte, Pa.	47.0	1980	5.9	42
		2000	11.2	91
		2020	19.4	146

E. WATER QUALITY MANAGEMENT (CONT'D)

Location	Surface Flow cfs (low August in 20 years)	Target Year	Projected Effluent Flow cfs	Flow Needed To Maintain Standard cfs
Lock Haven, Pa.	454.0	1980	46.4	320
		2000	59.5	518
		2020	80.0	656
Wellsboro, Pa.	0.8	1980	3.1	13
		2000	5.9	16
		2020	11.3	22

F. COAL MINE DRAINAGE POLLUTION ABATEMENT

	Estimated Average Daily Loading		
Watershed	Flow cfs	Acid tons	Iron tons
Beech Creek	13.3	10.9	2.2
Babb Creek	8.1	7.4	0.6
Loyalsock Creek	16.1	2.0	-
Total	37.5	20.3	2.8

G. FLOOD DAMAGE REDUCTION

Reach	Average Annual Damages $1,000
West Branch Susquehanna River - Kettle Creek to Lock Haven, Pa.	$ 803
West Branch Susquehanna River - Lock Haven, Pa., to Williamsport	632
West Branch Susquehanna River - Williamsport to Northumberland, Pa.	1,186
Bald Eagle Creek - Foster Joseph Sayers Dam to Lock Haven, Pa.	17
Upstream Watersheds	1,012
Total	$3,650

H. LAND TREATMENT

Total area needing treatment is 1,663,995 acres of which 11,231 acres of forest land, 459 acres of cropland, and 398 acres of pasture land need accelerated land treatment upstream from recommended reservoirs.

I. STREAMBANK STABILIZATION

Muncy Creek between Stoneville and Strawbridge, Pennsylvania
Little Muncy Creek just above confluence with Muncy Creek

SUB-BASIN VI

JUNIATA RIVER BASIN

A. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Service Area	Surface Flow cfs (low 7 days in 25 years)	Year	Estimated Population Served (1,000's)	Estimated M & I Water Use cfs
Altoona, Pa.	5.6	1980	100.0	32.2
		2000	143.0	51.5
		2020	207.0	74.7
Bellwood, Pa.	3.1	1980	6.2	2.6
		2000	9.2	4.6
		2020	14.3	8.2
Roaring Spring, Pa.	4.0	1980	3.8	10.0
		2000	6.9	16.3
		2020	13.0	23.3
Williamsburg, Pa.	11.6	1980	2.1	11.7
		2000	3.3	
		2020	5.1	25.2

B. AGRICULTURAL WATER SUPPLY

Projected Irrigation Demand

		1980	2000	2020
Estimated Maximum Withdrawal Rate	cfs	21	41	58
Estimated Volume Removal in Dry Years	Ac. Ft.	2330	4400	6300

C. GENERAL OUTDOOR RECREATION

Seasonal Recreation Demand Compared with 1980 Supply

		1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Water Oriented Recreation-Days		4531	4194	7592	12,363
Restricted Boating Acreage	Developed	705			
	Demand (1 ac/boat)		1760	3060	4,800
Unrestricted Boating Acreage	Developed	8300			
	Demand (2½ ac/boat)		2160	3760	5,910
	Demand (5 ac/boat)		4320	7530	11,830

D. FISH AND WILDLIFE

Projected Fishing Demand Compared with 1980 Supply

	1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Fisherman-Days	753	424	619	911

E. WATER QUALITY MANAGEMENT

Flows Needed to Maintain 5.0 mg/1 Dissolved Oxygen

Location	Surface Flow cfs (low August in 20 years)	Target Year	Projected Effluent Flow cfs	Flow Needed To Maintain Standard cfs
Altoona, Pa. (NE)	16.0	1980	10.4	15.5
		2000	19.9	30.6
		2020	38.6	60.7
Tyrone, Pa.	33.0	1980	16.1	42.0
		2000	22.9	93.0
		2020	31.6	146.0

E. WATER QUALITY MANAGEMENT (CONT'D)

Location	Surface Flow cfs (low August in 20 years)	Target Year	Projected Effluent Flow cfs	Flow Needed To Maintain Standard cfs
Altoona, Pa. (SW)	18.0	1980	16.1	34.0
		2000	18.6	80.0
		2020	31.8	151.0
Williamsburg, Pa.	59.0	1980	6.1	155.0
		2000	9.8	295.0
		2020	14.3	484.0

F. COAL MINE DRAINAGE POLLUTION ABATEMENT

	Estimated Average Daily Loading		
Watershed	Flow cfs	Acid tons	Iron tons
Longs Run	4.5	2.0	0.2
Six Mile Run	5.4	2.5	0.4
Shoups Run	17.1	2.0	0.2
Great Trough Creek	4.3	0.3	-
Roaring Run	0.8	0.6	-
Beaverdam Branch	15.3	6.0	0.8
Total	47.4	13.4	1.6

G. FLOOD DAMAGE REDUCTION

Reach	Average Annual Damages $1,000
Little Juniata River	$ 238
Frankstown Branch Juniata River	515
Raystown Branch Juniata River	545
Juniata River - Little Juniata River to Raystown Branch	301
Juniata River - Raystown Branch to Susquehanna River	557
Upstream Watersheds	1,051
Total	$3,207

H. LAND TREATMENT

Total area needing treatment is 1,405,598 acres of which 7,038 acres of forest land, 425 acres of cropland and 360 acres of pasture land need accelerated land treatment upstream from recommended reservoirs.

SUB-BASIN VII

SUSQUEHANNA RIVER BASIN - SUNBURY TO HARRISBURG, PA.

A. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Service Area	Surface Flow cfs (low 7 days in 25 years)	Year	Estimated Population Served (1,000's)	Estimated M & I Water Use cfs
Shippensburg, Pa.	2.1	1980	11.3	2.9
		2000	17.8	5.4
		2020	28.0	9.8
Carlisle, Pa.	36.0	1980	36.1	14.1
		2000	62.0	25.8
		2020	104.0	42.5
Harrisburg, Pa. West Shore	65.3	1980	132.5	23.1
		2000	294.5	51.4
		2020	517.0	119.5

B. AGRICULTURAL WATER SUPPLY

Projected Irrigation Demand

		1980	2000	2020
Estimated Maximum Withdrawal Rate	cfs	74	114	150
Estimated Volume Removal in Dry Years	Ac. Ft.	10,030	14,980	19,670

C. GENERAL OUTDOOR RECREATION

Seasonal Recreation Demand Compared with 1980 Supply

		1980 Supply	1980	2000	2020
1000's of Water Oriented Recreation Days		3092	11,459	20,716	33,650
Restricted Boating Acreage	Developed	230			
	Demand (1 ac/boat)		4,800	8,340	13,080
Unrestricted Boating Acreage	Developed	0			
	Demand ($2\frac{1}{2}$ ac/boat)		5,910	10,270	16,100
	Demand (5 ac/boat)		11,820	20,540	32,200

D. FISH AND WILDLIFE

Projected Fishing Demand Compared with 1980 Supply

	1980	Demand		
	Supply	1980	2000	2020
1000's of Fisherman-Days	1703	672	1059	1517

E. WATER QUALITY MANAGEMENT

Flows Needed to Maintain 5.0 mg/1 Dissolved Oxygen

Location	Surface Flow cfs (low August in 20 years)	Target Year	Projected Effluent Flow cfs	Flow Needed To Maintain Standard cfs
Shippensburg, Pa.	6.0	1980	2.6	7.5
		2000	5.6	16.0
		2020	10.0	26.0
Carlisle, Pa.	68.0	1980	6.4	33.0
		2000	13.6	68.0
		2020	25.7	110.0
Mechanicsburg, Pa.	80.0	1980	7.4	6.1
		2000	10.4	10.0
		2020	13.5	14.0

F. COAL MINE DRAINAGE POLLUTION ABATEMENT

Watershed	Estimated Average Daily Loading Flow cfs	Acid tons	Iron tons
Shamokin Creek	38.1	16.4	12.7
Mahonoy Creek	98.4	22.0	16.7
Mahantango Creek	14.3	3.0	1.1
Wiconisco Creek	20.3	1.1	1.8
Total	170.1	42.5	32.3

G. FLOOD DAMAGE REDUCTION

Reach	Average Annual Damages $1,000
Susquehanna River - West Branch to Juniata River	$ 319
Susquehanna River - Juniata River to Harrisburg, Pa.	246
Upstream Watersheds	624
Total	$1,189

H. LAND TREATMENT

Total area needing treatment is 842,925 acres of which 12,579 acres of forest land, 1,622 acres of cropland and 946 acres of pasture land need accelerated land treatment upstream from recommended reservoirs.

SUB-BASIN VIII

SUSQUEHANNA RIVER BASIN - HARRISBURG TO CHESAPEAKE BAY

A. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Service Area	Surface Flow cfs (low 7 days in 25 years)	Year	Estimated Population Served (1,000's)	Estimated M & I Water Use cfs
Elizabethtown, Pa.	0.3	1980	17.9	2.7
		2000	33.8	5.5
		2020	63.0	10.3
Lititz, Pa.	0.6	1980	10.4	3.8
		2000	18.7	7.9
		2020	32.0	13.6
York, Pa.	15.5	1980	190.0	51.0
	52.7*	2000	279.0	81.7
		2020	418.0	136.2
Hanover, Pa.	3.2	1980	38.2	8.5
	15.5*	2000	63.4	15.7
		2020	104.0	25.0
Manheim, Pa.	2.8	1980	11.4	3.4
		2000	19.9	6.5
		2020	34.0	12.0
Morgantown, Pa.	0.2	1980	2.9	0.5
		2000	5.1	1.0
		2020	9.2	2.0
New Holland, Pa.	0.06	1980	8.6	3.4
		2000	15.8	5.6
		2020	29.0	7.6
Spring Grove, Pa.	5.1	1980	5.6	50.8
	65.1*	2000	12.0	56.4
		2020	23.0	58.3

A. MUNICIPAL AND INDUSTRIAL WATER SUPPLY (CONT'D)

Service Area	Surface Flow cfs (low 7 days in 25 years)	Year	Estimated Population Served (1,000's)	Estimated M & I Water Use cfs
Ephrata, Pa.	4.3	1980	16.8	3.3
		2000	36.0	8.2
		2020	72.0	18.8
Lancaster, Pa.	22.8	1980	179.0	45.9
(not counting		2000	264.0	80.3
Susquehanna		2020	395.0	129.7
use potential)				

* Reflects yield of existing surface storage.

B. AGRICULTURAL WATER SUPPLY

Projected Irrigation Demand

		1980	2000	2020
Estimated Maximum Withdrawal Rate	cfs	100	142	186
Estimated Volume Removal in Dry Years	Ac. Ft.	13,560	18,640	24,380

C. GENERAL OUTDOOR RECREATION

Seasonal Recreation Demand Compared with 1980 Supply

		1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Water Oriented Recreation-Days		6,566	12,401	22,411	36,326
Restricted Boating Acreage	Developed	340			
	Demand (1 ac/boat)		5,190	9,020	14,120
Unrestricted Boating Acreage	Developed	21,167			
	Demand (2½ ac/boat)		6,390	11,110	17,380
	Demand (5 ac/boat)		12,790	22,220	34,770

D. FISH AND WILDLIFE

Projected Fishing Demand Compared with 1980 Supply

	1980 Supply	Demand 1980	Demand 2000	Demand 2020
1000's of Fisherman-Days	1933	2658	4213	6009

E. WATER QUALITY MANAGEMENT

Flows Needed to Maintain 5.0 mg/1 Dissolved Oxygen

Location	Surface Flow cfs (low August in 20 years)	Target Year	Projected Effluent Flow cfs	Flow Needed To Maintain Standard cfs
Lebanon, Pa.	19.0	1980	20.4	116.0
		2000	35.2	160.0
		2020	54.2	234.0
Hershey-Hummelstown, Pa.	55.0*	1980	3.4	140.0
		2000	5.6	200.0
		2020	11.2	264.0
Elizabethtown, Pa.	1.3	1980	4.3	12.0
		2000	9.6	19.0
		2020	20.5	44.0
Ephrata, Pa.	10.0	1980	2.5	7.2
		2000	4.5	23.0
		2020	9.1	53.0
Lititz, Pa.	1.3	1980	2.5	15.0
		2000	5.9	19.0
		2020	7.8	26.0
Lancaster, Pa.	55.0	1980	32.6	81.0
		2000	32.6	97.0
		2020	32.6	119.0
Safe Harbor Reservoir Pool	3360.0	1980		2400.0
		2000		3400.0
		2020		4300.0

E. WATER QUALITY MANAGEMENT (CONT'D)

Location	Surface Flow cfs (low August in 20 years)	Target Year	Projected Effluent Flow cfs	Flow Needed To Maintain Standard cfs
Conowingo Reservoir Pool	3480.0	1980		2700.0
		2000		3500.0
		2020		4300.0
Downstream from Conowingo Dam	3510.0	1980		2000.0
		2000		2500.0
		2020		3300.0

* Effect of Swatara Gap Dam not reflected.

F. COAL MINE DRAINAGE POLLUTION ABATEMENT

Watershed	Estimated Average Daily Loading Flow cfs	Acid tons	Iron tons
Swatara Creek	26.0	4.7	2.2

G. FLOOD DAMAGE REDUCTION

Reach	Average Annual Damages $1,000
Susquehanna River - Harrisburg to Mouth	$ 996
Upstream Watersheds	973
Total	$1,969

H. LAND TREATMENT

Total area needing land treatment is 1,401,066 acres of which 7,866 acres of forest land, 1,905 acres of cropland and 1,052 acres of pasture land need accelerated land treatment upstream from recommended reservoirs.

RESERVOIR RANKING TABLES

A. POTENTIAL UPSTREAM RESERVOIRS

Selection among upstream reservoir sites, depending on the intended use, was based on relative location, drainage area, size and depth of permanent pool, slope of adjacent land, land use, areas for preservation, reservoir shape, and site rank. Since ranking is a prominent reservoir selection factor, an explanation of how this was accomplished for the potential upstream reservoir sites will assist in interpreting the tables in this Attachment.

Every structure in the USDA Substudy Report, Susquehanna River Basin, Inventory of Potential Upstream Reservoir Sites, May 1968, was ranked by sub-basin using three rating factors: cost per surface acre, cost per acre-foot, and cost per cubic foot per second of added flow. For example, a sub-basin may have had 10 potential reservoir sites. Each site was ranked, lowest cost first and highest cost tenth, for each of the three factors. Next, a composite rank for each site was determined by adding the rank number for each cost factor, the total being the sub-basin points for each site shown in column 2 of the Upstream Reservoir Ranking Tables. Each reservoir was then given a composite rank in the sub-basin, again the one with the lowest number of points ranking highest.

TABLE 10

UPSTREAM RESERVOIR RANKING TABLES

SUB-BASIN I

SUSQUEHANNA RIVER BASIN UPSTREAM FROM ATHENS, PA.

98 Sites

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
48- 1	120	36	48- 5	143	41
2	113	33	6	177	59
3	287	98	7	283	96
4	59	19			
49- 1	126	38	49-23	17	4
2	209	73	25	189	65
3	26	9	28	114	34
5	21	7	30	39	12
8	178	60	31	198	70
13	20	6	32	151	46
14	144	43	33	72	23
18	88	31	34	169	52
22	87	30			
50- 1	82	28	50-10	159	48
2	160	50	11	214	78
4	155	47	12	172	56
5A	278	93	14	278	94
6	201	71	18	236	83
7	209	74	19	195	68
8	256	89	20	171	55
9	256	90			
51- 2	129	40	51-11	186	64
6	116	35	14	196	69
7	210	75	15	53	15
10	244	86			
51-18	123	37	51-22	171	54
19	270	91	23	239	85
20	211	76	24	230	81
21	284	97	25	144	42

SUB-BASIN I (CONT'D)

SUSQUEHANNA RIVER BASIN UPSTREAM FROM ATHENS, PA.

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
52- 4	278	92	52- 9	174	57
5	151	45	12	51	14
6	53	16	13	58	18
7	57	17	14	102	32
8	72	24	15	29	10
53- 1	12	2	53- 5	37	11
2	67	22	6	12	1
3	77	26	7	20	5
4	176	58	8	22	8
011- 9	234	82			
027- 1	47	13	027-10	159	49
4	245	87	11	279	95
6	246	88			
028- 1	171	53	028- 3	76	25
2	79	27	8	59	20
030- 2	67	21	030- 7	165	51
3	145	44	8	238	84
4	190	67	9	180	61
5	190	66	10	185	62
6	185	63			
031- 2	206	72	031- 4	226	80
3	83	29	5	213	77
032- 1	216	79			
2	129	39			
4	17	3			

SUB-BASIN II

CHEMUNG RIVER BASIN

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
42- 1	84	28	42- 3	34	11
2	66	25	6	87	30
43- 1	103	35	43- 6	7	2
2	58	20	11	94	31
3	11	3	12	99	33
4	35	12	13	97	32
5	85	29			
44- 1	60	21	44- 7	30	9
3	56	17	8	61	23
4	23	5	9	67	26
5	43	14	10	57	19
6	29	6			
46- 1	45	15	46-10	33	10
5A	55	16	14	102	34
7	5	1			
012- 1	30	8	012-12	61	24
8	17	4			
033- 1	74	27	033- 2	29	7
035- 1	56	18	035- 3	60	22
2	37	13			

SUB-BASIN III

SUSQUEHANNA RIVER BASIN - ATHENS TO SUNBURY, PA.

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
34- 1	234	79	34- 4	159	51
2	128	43	8	129	44
3	191	65			
35- 1	219	77	35- 4	125	40
2	46	13	5	195	67
36- 1	249	87	36- 7A	258	90
2	263	92	8	133	45
3	268	93	10	163	54
4A	275	98	12	161	52
5	211	73	13B	47	14
6	222	78			
37- 9	115	35	37-16	82	27
14	297	101	20	258	91
15	270	95			
38- 5	49	16	38-15	86	29
6	68	22	16	24	5
9	120	38	17	73	25
10	138	46	18	156	50
11	145	47			
39- 1	165	55	39- 6	255	88
3	248	84	10	219	76
4	273	96	11	247	83
40- 1	196	68	40- 5	269	94
2	209	72	7	287	100
3	176	60	8	275	97
4	217	75	10	128	42
41- 1	175	58	41- 8	245	82
2	182	62	9	215	74
4	244	81	10	184	63
7	257	89	11	237	80
06- 1	249	86	06- 7	101	31
6	115	36	8	83	28

SUB-BASIN III (CONT'D)

SUSQUEHANNA RIVER BASIN - ATHENS TO SUNBURY, PA.

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
07- 1	52	17	07- 7	23	4
2	109	33	8	122	39
3A	179	61	9	37	10
5	152	49	10	97	30
6	39	12	11	37	11
08- 1	67	21	08- 8	175	59
3	16	2	9	7	1
4	24	6	10	78	26
5	31	7	11	126	41
6	35	9			
09- 1	52	18	09- 2	66	20
010- 1	195	66	010-11	204	70
2	199	69	12	64	19
3	248	85	13	119	37
6	161	53	14	47	15
7	102	32	15	23	3
9	168	57	18	277	99
10	32	8			
011- 1	168	56	011- 5	69	23
3	71	24	6	188	64
4	114	34	7	206	71
019- 1	147	48			

SUB-BASIN IV

WEST BRANCH, SUSQUEHANNA RIVER - UPSTREAM FROM RENOVO, PA.

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
18- 1A	81	26	18- 5	44	12
3	100	35	6	42	10
19- 1	57	16	19- 7	69	22
5	115	39			

SUB-BASIN IV (CONT'D)

WEST BRANCH, SUSQUEHANNA RIVER - UPSTREAM FROM RENOVO, PA.

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
20- 1	23	6	20-11	7	1
2	95	33	12	35	9
3	89	27	13	104	37
5	25	7	14	89	28
6	62	18	15	14	5
7	26	8	16	56	15
9	43	11	18	52	13
10	94	31			
25- 1A	135	48	25- 2	116	40
26- 1D	10	3	26- 4	122	44
2B	11	4	5	122	45
3A	9	2			
27- 1	68	21	27- 7	144	50
2	102	36	9	164	54
3	171	57	10	164	55
5	116	41	11	141	49
5A	145	52	12	171	58
6	94	32	13	167	56
6A	160	53	14	117	42
28- 2A	144	51	6A	52	14
3	71	24	7	70	23
4	91	29	7B	127	47
025- 1	98	34	025- 5B	71	25
2	126	46	6	113	38
3	66	20	7	61	17
4	92	30	8	118	43
026- 1	62	19			

SUB-BASIN V

WEST BRANCH, SUSQUEHANNA RIVER - RENOVO TO SUNBURY, PA.

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
14- 1	85	28			
15- 1	53	18			
16- 1	33	10	16- 4A	121	41
2	73	26			
17- 1	101	37	17- 3	99	36
2	112	39	4	92	31
21- 1	46	16	21- 4	103	38
2	64	21	5	69	24
3	66	23	8	29	9
22- 1	73	25	22- 6	40	14
4	6	2	8	27	7
5	34	11			
23- 1	97	33	23- 8	99	35
2	129	43			
24- 1	121	40	24- 4	92	30
3	130	44	5	5	1
020- 1	65	22	020- 5A	21	4
2	45	15	7	23	5
3	38	12	8	25	6
4	50	17			
021- 1	28	8	021- 3	85	27
022- 1	98	34	022- 3	97	32
023- 1	17	3	023- 4	126	42
2	39	13	5	92	29
024- 1	54	19	124- 2	64	20

SUB-BASIN VI

JUNIATA RIVER BASIN

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
7- 2A	105	37	7- 8	95	35
4A	67	23	9	71	25
5A	66	21	10	12	3
6A	100	36	12	108	38
7A	133	45	14	134	47
8- 1	49	13	8- 8	12	2
2	36	9	9	61	16
4	34	8	10	20	4
7	66	20	11	4	1
9- 2	20	5	9- 7	75	28
4	32	7			
10- 6	132	43	10-11	91	33
10	56	14	13	66	19
11- 3	86	31	11-11A	178	59
5A	192	63	14	193	64
6	179	60	16A	193	65
9	186	62	17	196	66
12- 7	168	56	12-12	182	61
8	172	57			
013- 1A	64	17	013- 4	73	26
2	41	11	5	60	15
015- 2	133	44	015-10	80	29
6	113	39	11	68	24
9	166	54	14	36	10
016- 1	85	30	016-10	175	58
2	95	34	14	138	49
3	30	6	15	125	42
8	65	18	16	44	12
9	66	22			

SUB-BASIN VI (CONT'D)

JUNIATA RIVER BASIN

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
017- 4B	86	32	017-13	148	52
7	73	27	17	133	46
8	144	50	19	115	40
11	120	41			
018- 1	160	53	018- 4	167	55
2	137	48	5	148	51

SUB-BASIN VII

SUSQUEHANNA RIVER BASIN - SUNBURY TO HARRISBURG, PA.

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
5-11	153	52	5-23	64	17
13	40	10	29	80	27
15	66	19	35	161	54
18	133	49	36	159	53
21	67	20			
6- 1	47	13	6- 7	127	47
2	119	43	9	95	31
4	80	28	11	120	44
5	109	39	13	76	25
6	118	41	14	109	38
13- 1	150	51	13- 5	42	12
2	62	16	636	20	6
3	113	40	637	48	14
4	125	46	638	67	21
32- 1	10	2	32- 7	64	18
2	49	15	8	19	5
4	35	9	9	88	30
5	22	7			
33- 3	103	35	6	67	22
4	103	34			

SUB-BASIN VII (CONT'D)

SUSQUEHANNA RIVER BASIN - SUNBURY TO HARRISBURG, PA.

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
04- 1	15	4	04- 7	108	36
2	68	23	8	86	29
3	163	55	9	9	1
5	80	26			
05- 3	72	24	05- 5	102	33
4	127	48	6	125	45
014- 1A	13	3	014- 6	101	32
2	141	50	7	108	37
3	119	42	8	41	11
4	33	8			

SUB-BASIN VIII

SUSQUEHANNA RIVER BASIN - HARRISBURG TO CHESAPEAKE BAY

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
29- 1	13	2	29- 4	118	39
3	26	8	5	68	21
30- 2	100	35	30-12	149	51
7	159	55	13A	125	43
8	95	31	14	90	29
9	149	52			
31- 1	47	14	31-11	47	15
2A	69	23	13	150	53
4	106	37	14	139	46
5	34	10	15	154	54
9	147	50	16	142	47
10	53	18			

SUB-BASIN VIII (CONT'D)

SUSQUEHANNA RIVER BASIN - HARRISBURG TO CHESAPEAKE BAY

Inventory Number	Sub-Basin Points	Sub-Basin Rank	Inventory Number	Sub-Basin Points	Sub-Basin Rank
1- 1	97	33	1- 5A	108	38
2	6	1	6	43	12
3	120	41			
3- 1	126	44	3- 6	90	30
2	38	11	7	45	13
3	68	22	8A	118	40
4	20	6	9	98	34
5	51	17	10A	82	27
4- 1	144	49	4- 6	75	25
2	17	3	7	143	48
5	101	36	11	19	5
01- 1	86	28	01- 4	66	20
3	47	16	5	133	45
02- 1	17	4	02- 7	22	7
4	63	19			
03- 1	29	9	03- 9	96	32
3	124	42	11	72	24
4	77	26			

TABLE 11

MAJOR RESERVOIR RANKING TABLES

SUB-BASIN I

SUSQUEHANNA RIVER UPSTREAM FROM ATHENS, PA.

Inventory Number	Project Name	Relative Cost Rankings Ac-Ft	cfs	Acre	Recr. Poten. Rank	Visual Quality Rating
108	Flemingsville	13	13	13	16	-
109	Catatonk	15	14	14	14	-
110	Whitney Pt (enlarge)	1	1	1	10	-
112	Genegantslet	10	11	12	3	Low
113	Greene	16	5	16	15	-
114	South Plymouth	6	6	11	5	Low
115	East Guilford	4	3	2	8	-
117	Copes Corner	9	7	4	9	Low
118	Mount Upton	11	10	8	11	Low
120	West Oneonta	8	12	9	12	Low
121	Davenport Center	3	4	6	2	Low
122	Middlefield	5	8	3	4	Low
147	Pitcher	14	15	15	6	-
149	Mann Brook *	7	9	7	7	Low
150	Little Egypt *	2	2	5	1	Low
152	Cortland	12	16	10	13	-

* Potential archeological impact.

SUB-BASIN II

CHEMUNG RIVER BASIN

Inventory Number	Project Name	Relative Cost Rankings Ac-Ft	cfs	Acre	Recr. Poten. Rank	Visual Quality Rating
95	Coopers Plains	4	6	3	3	-
96	Mud Creek	6	7	1	1	Medium
97	Fivemile Creek	2	5	2	2	Low
99	Tuscarora	1	1	4	5	Medium
100	Bennetts Creek *	3	2	5	4	Low
143	Westfield	5	3	6	-	-
146	Blossburg	7	4	7	-	-

* Potential archeological impact.

SUB-BASIN III

SUSQUEHANNA RIVER BASIN - ATHENS TO SUNBURY, PA.

Inventory Number	Project Name	Relative Cost Rankings Ac-Ft	cfs	Acre	Recr. Poten. Rank	Visual Quality Rating
75	Roaring Creek	17	7	15	9	-
76	Mainville	2	5	8	2	-
77	Jonestown	3	3	2	4	-
78	Forks	4	4	4	5	-
79	Nescopeck	8	10	11	3	-
80	Wapwallopen	11	13	6	1	Low
85	Keelersburg *	1	1	1	10	Medium
86	Bowman	13	17	16	18	-
87	Dixon	15	8	12	12	Medium
88	Mehoopany	10	12	13	8	Low
89	Meshoppen	6	9	5	7	-
90	Stevensville	7	11	9	14	Medium
91	Wysox	14	14	10	6	Low
92	Weston	16	2	17	19	-
93	Franklin Center	9	15	7	13	Low
94	Sugar Creek	5	6	3	11	Medium
140	Moosic	20	19	19	20	Low
141	Scranton	19	21	20	15	Low
144	Rush	21	20	21	16	-
145	Fall Brook	18	18	18	17	Low
154	Evans Falls	12	16	14	21	-

* Potential archeological impact.

SUB-BASIN IV

WEST BRANCH, SUSQUEHANNA RIVER - UPSTREAM FROM RENOVO, PA.

Inventory Number	Project Name	Relative Cost Rankings Ac-Ft	cfs	Acre	Recr. Poten. Rank	Visual Quality Rating
59	Castle Garden	7	7	8	11	-
64	Huntley	8	8	12	9	-
65	Howard	9	10	10	5	Low
66	Emporium	10	11	11	7	Medium
67	Zanmore *	3	5	6	12	Medium
69	Dimeling *	4	3	4	8	High
71	Frugality	11	12	9	6	-
74	Ostend	12	9	5	4	-
151	Little Round Top	6	6	7	10	-
155	Chest Creek	5	4	2	1	-
57	Kettle Creek (enlarge)	1	1	1	2	Medium
58	First Fork (enlarge)	2	2	3	3	-

* Potential archeological impact.

SUB-BASIN V

WEST BRANCH, SUSQUEHANNA RIVER - RENOVO TO SUNBURY, PA.

Inventory Number	Project Name	Relative Cost Rankings Ac-Ft	cfs	Acre	Recr. Poten. Rank	Visual Quality Rating
51	Barbours	2	1	1	5	-
52	Haleeka	5	4	4	6	-
53	Powys	4	3	2	4	-
55	Cammal	3	2	5	7	Low
132	Tivoli *	6	7	3	2	Medium
133	Galeton *	1	6	6	1	Medium
156	Babb Creek	7	5	7	3	-

* Potential archeological impact.

SUB-BASIN VI

JUNIATA RIVER BASIN

Inventory Number	Project Name	Relative Cost Rankings Ac-Ft	cfs	Acre	Recr. Poten. Rank	Visual Quality Rating
15	Millerstown	3	4	2	5	High
19	Mayes Bridge*	10	1	7	12	Low
22	Orbisonia	1	3	4	11	Medium
27	Yellow Creek	5	7	5	7	-
29	Cypher Station	6	2	6	9	-
33	Huntingdon	2	5	1	8	-
36	Petersburg	4	6	3	3	-
126	Seven Stars	7	8	9	10	Medium
129	Big Fill	11	12	11	6	-
131	Roots	12	11	12	1	-
17	Honey Creek	9	10	8	2	-
18	Kishacoquillas	8	9	10	4	-

* Potential archeological impact.

SUB-BASIN VII

SUSQUEHANNA RIVER BASIN - SUNBURY TO HARRISBURG, PA.

Inventory Number	Project Name	Relative Cost Rankings Ac-Ft	cfs	Acre	Recr. Poten. Rank	Visual Quality Rating
12	Shady Grove	3	3	3	2	High
13	Mongul	4	5	4	1	High
14	Sherman *	2	2	2	3	High
48	St. Paul Church	5	4	5	5	-
49	Kratzerville *	1	1	1	4	High
135	Marysville	6	-	6	6	-

* Potential archeological impact.

SUB-BASIN VIII

SUSQUEHANNA RIVER BASIN - HARRISBURG TO CHESAPEAKE BAY

Inventory Number	Project Name	Relative Cost Rankings Ac-Ft	cfs	Acre	Recr. Poten. Rank	Visual Quality Rating
3	Leaman Place	4	4	3	2	Medium
4	Frysville	2	3	2	1	High
5	Conestoga *	6	6	5	3	High
8	Reynolds Mill	5	5	6	4	Medium
10	Conewago	1	1	1	5	High
134	Hershey *	3	2	4	6	High

* Potential archeological impact.

TABLE 12

ADDITIONAL NEW YORK RESERVOIR RANKING TABLE

SUB-BASINS I AND II

CHEMUNG AND SUSQUEHANNA RIVER BASINS
UPSTREAM FROM ATHENS, PA.

Inventory Number	Project Name	Sub-Basin	Relative Cost Rankings			Recr. Poten. Rank
			Ac-Ft	cfs	Acre	
60NY	Halsey Valley	I	5	7	7	13
67NY	Prospect Valley	I	16	6	14	15
71NY	Pipe Creek	I	13	2	8	14
84NY	Wilson Creek	I	4	12	11	10
85NY	Weltonville	I	7	5	9	5
99NY	Jennings Creek	I	11	9	13	6
100NY	Culver Creek	I	1	13	12	17
110NY	Tioughnioga River	I	6	1	1	2
115NY	Union Valley	I	14	10	5	9
158NY	Lake Ludlow	I	12	15	6	8
165NY	Trowbridge	I	10	14	16	4
175NY	Wilkens Branch	I	2	11	10	7
198NY	West Edmeston	I	3	3	2	1
216NY	Wharton Creek	I	9	4	4	3
239NY	Fly Creek	I	8	8	3	11
23NY	Smith Run	II	15	16	15	-

ATTACHMENT 3

PLAN FORMULATION SUMMARY TABLE

The purpose of Attachment 3 is to show the results of using the multiple objective approach in the plan formulation process. The attachment consists of Table 13 which indicates whether a particular project was included in the Base, Economic Efficiency, Regional Development, Environmental Quality, Plan Formulation Workshop, or Coordinating Committee Plans. The table also includes brief remarks on each project pertinent to its status at the completion of the study.

TABLE 13
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
GROUNDWATER FOR WATER SUPPLY							
SUB-BASIN I							
Binghamton, N.Y.				X			Water supply storage in site 212 more economical
Cortland	X			X	X	X	Most economical alternative 1980
Hamilton	X	X	X	X	X	X	Most economical alternative 2000
Norwich		X					Water supply storage in site 114 more economical
SUB-BASIN II							
Bath					X		Water supply storage in site 97 more economical
Corning	X			X			Reevaluation of data indicated no need
Elmira	X	X		X	X		Water supply storage in sites 96 and 97
Hornell	X	X	X	X	X	X	Most economical alternative 1980
SUB-BASIN III							
Freeland, Pa.							Included with Hazleton service area
Hazleton	X	X	X	X	X	X	Most economical alternative 1980
Scranton							Poor water quality locally; pipeline to Susquehanna River more economical
SUB-BASIN IV							
Barnesboro	X	X	X	X	X	X	Most economical alternative 1980
Emporium						X	Most economical alternative 1980
Patton	X					X	Most economical alternative 1980
Philipsburg	X						Water supply storage in site 18-3
Spangler	X	X	X	X	X	X	Most economical alternative 1980
SUB-BASIN V							
Bellefonte		X	X	X	X	X	Most economical alternative 2020
Lock Haven	X						Based the assumption that the West Branch Susquehanna River would be available, no further source development is needed
State College				X	X	X	Most economical alternative 1980
Wellsboro		X	X	X	X	X	Most economical alternative 2020
Woolrich				X			Reevaluation of needs data indicated no need for further source development
							NOTES - Earliest selections were based on preliminary cost and benefit data. "X" denotes selection.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
GROUND WATER FOR WATER SUPPLY							
<u>SUB-BASIN VI</u>							
Altoona, Pa.		X		X	X	X	Most economical alternative 1980
Bellwood					X	X	Most economical alternative 1980
Roaring Springs		X	X	X	X	X	Most economical alternative 1980
Tyrone							Reevaluation of needs data indicated no need for further source development
Williamsburg							Reevaluation of needs data indicated no need for further source development
<u>SUB-BASIN VII</u>							
Carlisle				X	X		Water supply storage in site 12 more economical
Lykens							Reevaluation of needs data indicated no need for further source development
Mahanoy City			X	X			Reevaluation of needs data indicated no need for further source development
Shamokin		X		X			Reevaluation of needs data indicated no need for further source development
Tower City							Reevaluation of needs data indicated no need for further source development
Shippensburg		X	X	X	X		Water supply storage in site 12 more economical
<u>SUB-BASIN VIII</u>							
Elizabethtown					X	X	Most economical alternative 1980
Ephrata	X	X		X	X	X	Most economical alternative 1980
Hanover		X	X	X			Pipeline from Susquehanna River more economical
Hershey		X		X			Reevaluation of needs data indicated no need for further source development
Lancaster							Pipeline from Susquehanna River more economical
Lebanon							Reevaluation of needs data indicated no need for further source development
Lititz	X	X		X	X	X	Most economical alternative 1980
Manheim					X	X	Most economical alternative 1980
Morgantown	X	X		X	X	X	Most economical alternative 1980
New Holland	X	X		X	X	X	Most economical alternative 1980
Palmyra		X		X			Reevaluation of needs data indicated no need for further source development
Spring Grove							Reevaluation of needs data indicated no need for further source development
York				X			Pipeline from Susquehanna River more economical

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
PIPELINE FOR WATER SUPPLY							
SUB-BASIN I							
Hamilton, N.Y.							Ground water more economical
SUB-BASIN III							
Hazleton, Pa.							Ground water more economical (within Basin)
Scranton	X	X	X	X	X	X	Most economical alternative 1980
SUB-BASIN V							
Bellefonte							Ground water more economical
Lock Haven							Reevaluation of needs data indicated no need for further source development
State College	X	X	X				Ground water more economical in later analyses
SUB-BASIN VI							
Altoona	X		X				Ground water more economical
SUB-BASIN VII							
Shamokin Valley							Reevaluation of needs data indicated no need for further source development
Wiconisco Creek Valley							Reevaluation of needs data indicated no need for further source development
Shippensburg						X	Most economical alternative 1980

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
PIPELINE FOR WATER SUPPLY							
SUB-BASIN VIII							
Elizabethtown	X						Ground water more economical
Ephrata			X				Ground water more economical
Hershey	X						Already planned storage development in watershed should eliminate need for further source development
Lancaster	X	X	X	X	X	X	Most economical alternative 1980
Lebanon	X						Already planned storage development in watershed should eliminate need for further source development
Morgantown			X				Ground water more economical
York	X	X	X		X	X	Most economical alternative 1980
Palmyra	X						Already planned storage development in watershed should eliminate need for further source development
Hanover	X				X	X	Most economical alternative 1980
Spring Grove	X						Already planned storage development in watershed should eliminate need for further source development
New Holland			X				Ground water more economical
Lititz			X				Ground water more economical

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
ADVANCED WASTE TREATMENT FOR WATER QUALITY							
SUB-BASIN I							
Cortland, N.Y.					X		Low flow augmentation storage in site 49-28 more economical
Binghamton				X			Low flow augmentation storage in site 121 more economical
SUB-BASIN II							
Hornell		X	X	X	X	X	Most economical alternative 2000
Corning				X			Secondary treatment will be sufficient
Elmira				X		X	Most economical alternative 2000
SUB-BASIN III							
Hazleton, Pa.		X	X	X	X	X	Most economical alternative 2000
Scranton		X	X	X	X	X	Most economical alternative 2000
SUB-BASIN V							
Bellefonte		X	X	X	X	X	Most economical alternative 1980
Lock Haven					X	X	Most economical alternative 2000
State College	X	X	X	X	X	X	Most economical alternative 2000
Wellsboro		X	X	X	X	X	Most economical alternative 1980
SUB-BASIN VI							
Altoona	X	X	X	X	X	X	Most economical alternative 1980
Roaring Springs		X	X		X	X	Most economical alternative 1980
Tyrone		X			X	X	Most economical alternative 1980
Williamsburg		X			X	X	Most economical alternative 1980
SUB-BASIN VII							
Carlisle		X	X	X	X	X	Most economical alternative 1980
Lykens	X						Secondary treatment will be sufficient
Mahanoy City	X						Secondary treatment will be sufficient
Mechanicsburg					X	X	Most economical alternative 2000
Shippensburg		X	X	X	X	X	Most economical alternative 1980
Tower City	X						Secondary treatment will be sufficient
Shamokin						X	Most economical alternative 2000
Shenandoah						X	Most economical alternative 2000

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
ADVANCED WASTE TREATMENT FOR WATER QUALITY							
SUB-BASIN VIII							
Dallastown-York, Pa.					X	X	Most economical alternative 1980
Elizabethtown					X	X	Most economical alternative 1980
Ephrata	X		X	X	X	X	Most economical alternative 2000
Hanover			X	X	X	X	Most economical alternative 1980
Hershey				X	X		Secondary treatment will be sufficient
Lancaster			X		X	X	Most economical alternative 1980
Lebanon					X	X	Most economical alternative 1
Lititz	X		X	X	X	X	Most economical alternative 1980
Morgantown	X				X		Secondary treatment will be sufficient
New Holland				X	X	X	Most economical alternative 1980
York			X	X		X	Most economical alternative 1980
Palmyra				X			Secondary treatment will be sufficient
Fredericksburg						X	Most economical alternative 1980
New Freedom-Shrewsbury						X	Most economical alternative 1980
Red Lion						X	Most economical alternative 1980
Spring Grove						X	Most economical alternative 1980
Glen Rock						X	Most economical alternative 2000
Mt. Holly Springs						X	Most economical alternative 1980
Penn Township						X	Most economical alternative 1980
Annville						X	Most economical alternative 1980

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
WASTE DIVERSION FOR WATER QUALITY							
SUB-BASIN I							
Cortland, N.Y.							Low flow augmentation in [illegible] -28 more economical
Hamilton	X						Advanced waste treatment m[illegible] economical
Waverly	X						Not needed based on later analyses
SUB-BASIN II							
Elmira							Advanced waste treatment more economical
Hornell	X						Advanced waste treatment more economical
SUB-BASIN III							
Hazleton, Pa.	X						Advanced waste treatment more economical
Scranton	X						Advanced waste treatment more economical
SUB-BASIN IV							
Phillipsburg							Not needed
Wellsboro	X						Advanced waste treatment more economical
SUB-BASIN V							
Bellefonte							Advanced waste treatment more economical
Lock Haven	X						Advanced waste treatment more economical
State College							Advanced waste treatment more economical
SUB-BASIN VI							
Altoona	X						Advanced waste treatment more economical; base plan selection only for southwest plant
Roaring Springs							Advanced waste treatment more economical
Tyrone	X						Advanced waste treatment more economical

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
WASTE DIVERSION FOR WATER QUALITY							
SUB-BASIN VII							
Carlisle, Pa.				X	X	X	Included with collection system
Clearfield							Receiving stream can assimillate after secondary treatment
Frackville							Receiving stream can assimillate after secondary treatment
Mahanoy City							Receiving stream can assimillate after secondary treatment
Mechanicsburg	X						Advanced waste treatment more economical
Shamokin City	X						Advanced waste treatment more economical
Shenandoah							Advanced waste treatment more economical
Shippensburg	X						Advanced waste treatment more economical
SUB-BASIN VIII							
Dallastown							Advanced waste treatment more economical
Elizabethtown	X						Advanced waste treatment more economical
Ephrata		X					Advanced waste treatment more economical
Fredericksburg							Advanced waste treatment more economical
Hanover	X	X					Advanced waste treatment more economical
Hershey	X						Receiving stream can assimillate after secondary treatment
Lancaster	X	X	X				Advanced waste treatment more economical
Lebanon	X						Advanced waste treatment more economical
Morgantown		X					Advanced waste treatment more economical
New Holland	X	X					Advanced waste treatment more economical
Oxford							Receiving stream can assimillate after secondary treatment
Palmyra	X						Receiving stream can assimillate after secondary treatment
Red Lion							Advanced waste treatment more economical
Spring Grove	X				X		Advanced waste treatment more economical
York	X	X			X		Advanced waste treatment more economical
Lititz		X					Advanced waste treatment more economical

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TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
LOCAL FLOOD PROTECTION PROJECTS							
SUB-BASIN I							
Bainbridge, NY							Economically unjustifiable
Binghamton, NY							Economically unjustifiable
Caste Gardens, NY							Benefit-cost ratio with economic growth & adjustment factors is 0.48
Cayuta, NY							Benefit-cost ratio without economic factors is 0.1
Chenango Forks, NY							Benefit-cost ratio with economic factors is less than unity
Conklin Station, NY							Benefit-cost ratio with economic factors is less than unity
Cortland, NY							Existing project sufficient for flood of record
Edmenston, NY							No damage data available
Endicott, NY							Economically unjustifiable
Endwell, NY							Benefit-cost ratio less than unity
Fairmont Park, NY							Benefit-cost ratio with economic factors is 0.56
Greene, NY							Economically unjustifiable
Homer, NY							Benefit-cost ratio without economic factors is 0.3
Johnson City, NY							Economically unjustifiable
Julius Rog Sch, NY							Benefit-cost ratio with economic factors less than unity
Killawog, NY							Benefit-cost ratio with economic factors less than unity
Lisle, NY							Economically unjustifiable
Marathon, NY	X	X				X	Channel project; economically justifiable 1980
New Berlin, NY							Benefit-cost ratio without economic factors is 0.05
Norwich, NY							Benefit-cost ratio with economic factors is 0.47
Oak Dale & Westover, NY							Economically unjustifiable
Oneonta, NY							Economically unjustifiable
Ouaquaga, NY							Benefit-cost ratio with economic factors is less than unity
Oxford, NY							Economically unjustifiable
Owego, NY							Economically unjustifiable
Poolville, NY							Existing protection is sufficient
Port Crane, NY							Benefit-cost ratio with economic factors is 0.6
Sayre, Pa.							Existing protection is sufficient
Sidney, NY							Economically unjustifiable
Truxton, NY							Benefit-cost ratio without economic factors is 0.2
Unadilla, NY							Benefit-cost ratio with economic facors is 0.6
Union Center, NY							Benefit-cost ratio without economic factors is 0.1
Vestal, NY							Economically unjustifiable
Whitney Point, NY							Economically unjustifiable
Port Dickinson, NY							Economically unjustifiable

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
LOCAL FLOOD PROTECTION PROJECTS							
SUB-BASIN II							
Addison, NY							Economically unjustifiable
Avoca, NY							Economically unjustifiable
Bath, NY							Economically unjustifiable
Bloosburg, Pa.							Existing channel is sufficient
Campbell, NY							Economically unjustifiable
Canisteo, NY							Economically unjustifiable
Coopers Plains, NY							Economically unjustifiable
Corning, NY							Economically unjustifiable
Covington, Pa.							Economically unjustifiable
Elkland, Pa.							Economically unjustifiable
Elmira, NY							Existing project with Tioga-Hammond project is sufficient
Elmira Heights, NY			X				Soil Conservation Service has comprehensive plan for Newtown Creek
Harrison Valley, Pa							Benefit-cost ratio with economic factors is 0.29
Horseheads, NY							Economically unjustifiable
Knoxville, Pa.	X	X			X		Economically unjustifiable after reanalysis
Painted Post, NY							Economically unjustifiable
South Corning, NY							Economically unjustifiable
Westfield, Pa.	X	X			X	X	Channel project; benefit-cost ratio @ 4-7/8% is more than unity 1980
SUB-BASIN III							
Archbald, Pa.							Economically unjustifiable
Athens, Pa.							Economically unjustifiable
Bloomsburg, Pa.	X		X	X	X	X	Levee and wall project; essential for development of the region; economically unjustifiable at 4-7/8% 1980
Carbondale, Pa.							Economically unjustifiable
Danville, Pa.							State has a project
Duryea, Pa.							Economically unjustifiable
Edwardsville, Pa.	X					X	Part of Wilkes-Barre project (see below) 1980
Falls, Pa.							Economically unjustifiable
Forty Fort, Pa.	X					X	Part of Wilkes-Barre project (see below) 1980
Hanover Twnshp, Pa	X					X	Part of Wilkes-Barre project (see below) 1980
Kingston, Pa.	X				X	X	Part of Wilkes-Barre project (see below) 1980
Olyphant, Pa.							Economically unjustifiable
Plains Twnshp, Pa.							Economically unjustifiable
Plainsville, Pa.							Preliminary benefit-cost ratio is 0.14

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
LOCAL FLOOD PROTECTION PROJECTS							
Plymouth, Pa.							Economically unjustifiable
St. Johns, Pa.							Soil Conservation Service has an authorized project
Shickshinny, Pa.							Economically unjustifiable
Simpson, Pa.							Economically unjustifiable
Skinners Eddy, Pa.							Benefit-cost ratio with economic factors is less than unity
Swoyersville, Pa.							Part of Wilkes-Barre project (see below)
Towanda, Pa.							Economically unjustifiable
West Falls, Pa.							Benefit-cost ratio with economic factors is 0.14
W. Nanticoke, Pa.			X				Economically unjustifiable
W. Pittston, Pa.							Benefit-cost ratio without economic factors is 0.19
Wilkes-Barre, Pa.	X		X	X	X	X	Raising of existing protection; project economically justified; referred to as Wyoming Valley project in Appendix K(II) 1980
SUB-BASIN IV							
Clearfield, Pa.							Economically unjustifiable
Curwensville, Pa.							Benefit-cost ratio without economic factors is 0.28
Hastings, Pa.							No damage data available; Soil Conservation Service looking for project
Hyde, Pa.							Damages have been considerably reduced with Curwensville Dam; Economically unjustifiable
Renovo, Pa.							Economically unjustifiable
Riverview, Pa.							Economically unjustifiable
South Renovo, Pa.							Economically unjustifiable
Westover, Pa.							No damage data available; Soil Conservation Service looking for project
Westport, Pa.							Benefit-cost ratio with economic factors is 0.23
Philipsburg, Pa.					X	X	State Project 1980
SUB-BASIN V							
Avis, Pa.							Benefit-cost ratio with economic factors is 0.09
Beech Creek, Pa.							Economically unjustifiable
Bull Run (Williamsport), Pa.							Economically unjustifiable
Duboistown, Pa.							Benefit-cost ratio with economic factors is 0.36
Jersey Shore, Pa.							Economically unjustifiable
Lewsiburg, Pa.							Economically unjustifiable
Lock Haven, Pa.	X	X	X		X	X	Levee and wall project; essential for further development; economically justified at 3-1/4%, just barely at 4-7/8% 1980
Loyalsock Township, Pa.							Economically unjustifiable
Milton, Pa.							Benefit-cost ratio with economic factors is 0.55
Montgomery, Pa.							Economically unjustifiable

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
LOCAL FLOOD PROTECTION PROJECTS							
Montoursville, Pa.							Benefit-cost ratio with economic factors is 0.18
Muncy, Pa.							Economically unjustifiable
Newberry, Pa.							Economically unjustifiable
Williamsport, Pa.							Economically unjustifiable
Winfield, Pa.							Benefit-cost ratio with economic factors is 0.12
SUB-BASIN VI							
Alexandria, Pa.							Benefit-cost ratio with economic factors is 0.56
Bedford, Pa.							Economically unjustifiable
Burnham, Pa.							No damage data available; Soil Conservation Service looking for project
Everett, Pa.							State has a project
Frankstown, Pa.							No damage data is available
Hollidaysburg, Pa.							No damage data is available
Hope Well, Pa.							Benefit-cost ratio with economic factors is 0.23
Huntingdon, Pa.							Economically unjustifiable
Ironsville, Pa.							Benefit-cost ratio with economic factors is 0.6
Kistler, Pa.							Economically unjustifiable
Lewistown, Pa.							Benefit-cost ratio with economic factors is 0.5
Mapleton, Pa.							Economically unjustifiable
Mifflin, Pa.							Economically unjustifiable
Mill Creek, Pa.							Benefit-cost ratio with economic factors is 0.26
Mount Union, Pa.							Benefit-cost ratio with economic factors is 0.26
Newport, Pa.							Benefit-cost ratio with economic factors is 0.3
Newtown Hamilton, Pa							Economically unjustifiable
Petersburg, Pa.							Benefit-cost ratio with economic factors is 0.47
Port Royal, Pa.							Damages would be reduced considerable with Raystown Dam; benefit-cost ratio without economic factors is 0.05
Riddlesburg, Pa.							Economically unjustifiable
Smithfield Township, Pa.							Economically unjustifiable
Tipton, Pa.							Benefit-cost ratio with economic factors less than unity
Williamsburg, Pa.					X		Economically unjustifiable
McVeytown, Pa.							Economically unjustifiable

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TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
LOCAL FLOOD PROTECTION PROJECTS							
SUB-BASIN VII							
Conodoguinet Creek Area, Pa.							Benefit-cost ratio with economic factors is 0.1
Duncannon, Pa.							Economically unjustifiable
Duncan Island, Pa.							Benefit-cost ratio with economic factors is 0.2
Fort Hunter, Pa.							Benefit-cost ratio with economic factors is 0.2
Harolds Run Area, Pa.							Benefit-cost ratio with economic factors is 0.16
Harrisburg, Pa.							Economically unjustifiable
Linglestown Rd. Area, Harrisburg, Pa.							Economically unjustifiable
Linkersville, Pa.							Benefit-cost ratio with economic factors is 0.04
Marysville, Pa.							Benefit-cost ratio with economic factors is 0.05
Millersburg, Pa.							Benefit-cost ratio with economic factors is 0.02
Mount Carmel, Pa.							No damage data available
Rockville, Pa.							Benefit-cost ratio with economic factors is 0.08
Selinsgrove, Pa.							Economically unjustifiable
Shadynook, Pa.							Benefit-cost ratio with economic factors is 0.11
Shamokin Dam, Pa.							Benefit-cost ratio with economic factors is 0.1
Sunbury, Pa.							Existing protection is sufficient
West Fairview, Pa.							Benefit-cost ratio with economic factors is 0.15
Wormleysburg, Pa.							Benefit-cost ratio with economic factors is 0.06
SUB-BASIN VIII							
Goldsboro, Pa.							Benefit-cost ratio with economic factors is 0.04
Highspire, Pa.							Economically unjustifiable
Lower Swatra Twp, Pa.							Economically unjustifiable
Manheim, Pa.							Economically unjustifiable
Marietta, Pa.							Economically unjustifiable
Middletown, Pa.							Economically unjustifiable
New Cumberland, Pa.							Economically unjustifiable
New Market, Pa.							Benefit-cost ratio with economic factors is .06
Olmsted AFB Area, Pa.							No damage data available
Paxton Cr Area, Pa.	X	X	X		X	X	Economically justifiable. Essential for development. 1980
Poor House Run, Pa.							Economically unjustifiable
Royalton, Pa.							Economically unjustifiable
Steelton, Pa.							Economically unjustifiable
York, Pa.							Economically unjustifiable

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
RESERVOIR SITES							
SUB-BASIN I							
108							Less economical than alternatives; Low potential for regional development; Not considered an improvement to the environment; Not compatible with any of three objectives.
109							Less economical than alternatives; Low potential for regional development; Not considered an improvement to the environment; Not compatible with any of three objectives.
112	X		X	X			Needed for Flood Control and Recreation in late action period; Not economically justified; Good location for Regional Development, Flood Control and Recreation will stimulate economy; Considered an improvement to the environment; South Plymouth site in better location for multiple-purpose use.
113							Less economical than alternatives; Low multiple-purpose potential; Reservoir on Chenango River not considered desirable; Not compatible with any of three objectives.
114	X		X	X	X	X	Good multiple-purpose potential; Less economical than alternatives from National point of view; Good potential for regional development; Secondary benefits for Flood Control and Recreation should stimulate economy; Much recreation potential with varied shoreline potential; Good location to meet Flood Control, Recreation, Water Supply, and Water Quality needs and to enhance regional growth. 1980.
115			X		X	X	Less economical than alternatives; Initially not quite economically justified; Good location for Regional Development, Flood Control and Recreation will stimulate economy; Would destroy an attractive area; Further data indicated this is close to being economically justified; Best alternative to meet long-range Low Flow Augmentation and Flood Control needs 2000.
117	X						Appeared better size than other alternatives in this area; Not economically justified; Not as much potential as #115; Not considered an improvement to the environment; #115 has more potential for more multiple-purpose uses.
118							Too disruptive; Not as efficient as alternatives; Not as much potential as #115; Considered detriment of the environment; #115 considered more desirable for each of Economic Efficiency, Regional Development and Environmental Quality objectives.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
RESERVOIR SITES							
120							Not much potential for multiple-purpose use; Not economically justified; Not much potential to stimulate economy; Narrow reservoir, not considered an enhancement to the environment; Not much potential for any of three objectives.
121	X	X	X		X	X	Good potential for multiple-purpose use; Economically justified; Good potential for economic stimulation from Flood Control and Recreation uses; Expected benefits plus regional development potential support its inclusion. 1980
122	X						Good location for multiple-purpose use; Not economically justified; Poor location to stimulate economy; Not considered as an enhancement to the environment; Not compatible with any of three objectives.
147							Much less efficient than alternatives; Not economically justified; Poor location and low potential to stimulate economy; Conflict with fishery stream; Not compatible with any of three objectives.
149							Much less efficient than alternatives; Not economically justified; Poor location and low potential to stimulate economy; Conflict with fishery stream; Not compatible with any of three objectives.
150							Too disruptive; staged impoundment desirable rather than all at once; Not economically justified; Several smaller reservoirs deemed more desirable to spread around economic impact; Not considered an enhancement to the environment; Environmental quality deemed primary objective for main stem.
152							Much less efficient than alternatives; Not economically justified; Low potential to stimulate economy; Conflict with fishery stream; Not compatible with any of three objectives.
NY 60							Not as desirable as alternatives; Not economically justified; Too small; Narrow reservoir not considered an enhancement to the environment; Not compatible with any of three objectives.
NY 67							Much less efficient than alternatives; Not economically justified; Too small; Not considered an enhancement to the environment; Not compatible with any of three objectives.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
RESERVOIR SITES							
NY 71							Less efficient than alternatives; Not economically justified; Low potential to stimulate economy; Not considered an enhancement to the environment; Not compatible with any of three objectives.
NY 84							Too small; More net benefits from larger multiple-purpose alternatives; Too small for Regional Development; Not considered an enhancement to the environment; Not as desirable as alternatives.
NY 85					X	X	Needed for recreation; some potential for Regional Development in Owego area; 2000
NY 99		X	X		X	X	Economically justified; Good location to stimulate economy; Needed for recreation; selected for Regional Development potential; 2000
NY 100							Less multiple-purpose potential than alternatives; Not as many net benefits as alternatives; Too small to stimulate economy; Not considered an enhancement to the environment; Not compatible with any of three objectives.
NY 110							Same as 49-28 listed elsewhere.
NY 115							Not as desirable as alternatives; Not economically justified; Isolated location for Regional Development stimulation; Conflicts with high value farms; Not compatible with any of three objectives.
NY 158		X					Not as much multiple-purpose potential as alternatives; Poor location and too small; Conflicts with existing swamps; Not as desirable as alternatives.
NY 165		X					Too small; less desirable than alternatives; Too small for Regional Development impact; Not considered an enhancement to the environment; Not as desirable as alternatives; low multiple-purpose potential.
NY 175		X					Too small; less desirable to alternatives; Low potential to stimulate economy; Not considered an enhancement to the environment;
NY 198		X	X				Not as desirable as alternatives; Too disruptive; Not as much multiple-purpose potential as alternatives.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
RESERVOIR SITES							
NY 216							Not needed for multiple-purpose use; Not as desirable as alternatives; May hurt economy more than help it; Conflicts with good fishery stream; Not compatible with any of three objectives.
NY 239							Low potential for multiple-purpose use; Not as desirable as alternatives; Low potential to stimulate economy; Conflicts with good fishing streams; Not as much potential as alternatives.
<u>SUB-BASIN II</u>							
95							Not as much multiple-purpose potential as alternatives; Not economically justified; Low potential to stimulate economy; Conflict with fishing stream; Not compatible with any of three objectives.
96	X	X	X	X	X	X	Good multiple-purpose potential; Economically justified; High recreation potential to stimulate economy; Considered an enhancement to existing area; Compatible with all three objectives. 1980.
97	X					X	Good location for multiple-purpose use; Not deemed necessary for desired economic growth of the region. Strong support from N.Y. Division of Water Resources. 1980.
99	X		X	X			Too expensive; Not economically justified; Configuration too costly for the benefits to be gained.
100	X		X				Not economically justified; Desirable for regional development; Conflicts with archaeologic value; Low potential; Not as desirable as alternatives.
143							Not as desirable as alternatives; Not economically justified; Would inundate school and harm local economy; Not considered an enhancement to the environment; Not compatible with any of three objectives.
146							Low multiple-purpose potential; Not economically justified; Low potential to stimulate economy; Not considered an enhancement to the environment; Not compatible with any of three objectives.
NY 23							Low multiple-purpose potential; Not economically justified; Low potential to stimulate economy; Not considered an enhancement to the environment; Not compatible with any of three objectives.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
RESERVOIR SITES							
SUB-BASIN III							
75							Too small; Not as efficient as alternatives; Not economically justified; Not enough potential to stimulate economy; Not considered as enhancing the environment; Not compatible with any of three objectives.
76							Not as much potential for multiple-purpose use as alternatives; Not economically justified; Not as desirable as alternatives for stimulation from recreation use; Not considered as enhancing the environment; Not compatible with any of three objectives.
77			X		X	X	Close to growth centers; Good recreation potential; Needed for recreation and desirable for Regional Development. 2020
78							Not as much potential as alternatives; Not economically justified; Would hurt economy by inundating fishery streams; Conflicts with good fishing streams.
79							Not as much multiple-purpose potential as alternatives; Appeared close to being economically justified; Low potential for economic stimulation; Not considered as enhancing the environment; Not as desirable as alternatives.
80	X	X	X	X	X	X	Outstanding recreation potential; Economically justified; Close to growth centers; Attractive configuration would fit in setting well; Compatible with all three objectives; 2000 Plan; Low dams preferred for early action at Berwick.
85		X					Too large; not as desirable as several smaller sites; However, with power it appeared close to being economically justified; Not compatible with region's desires for preservation; Conflicts with attractive reach of River; Conflicts with Regional Development and Environmental Quality objectives for this area.
86							Not as desirable as alternatives; Low potential; Not economically justified; Not compatible with region's desires for preservation; Conflicts with good fishing streams; Not suitable for any of three objectives.
87	X				X	X	Promising recreation alternative; Regional Development potential warrants its inclusion. 2020.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
RESERVOIR SITES							
88	X						Low multiple-purpose potential; Not economically justified; Low potential tq stimulate economy; Conflicts with good fishing stream.
89							Low multiple-purpose potential; Not economically justified; Low potential to stimulate economy; Not considered as enhancement to environment; Not compatible with any of three objectives.
90	X			X			Ranked low based on Average Annual Costs/acre; Not economically justified; Potential to stimulate economy not deemed adequate for required investment; Compliments its setting; deemed as enhancing the environment; Selected other reservoirs closer to growth centers for regional development.
91	X						Good location; Good potential based on initial analysis; Not economically justified; Low potential to stimulate economy; Not considered an enhancement to the environment; Not compatible with any of three objectives.
92							More expensive than alternatives; Not economically justified; Low potential to stimulate economy; More desirable to leave stream in free-flowing condition; Environmental Quality deemed most important objective for this stream.
93	X	X	X				Straight reservoir not deemed as enhancing the environment; Not deemed as desirable as alternatives closer to larger growth centers.
94							Conflicts with high value agriculture land; Not economically justified; Not deemed as enhancing the environment; Not compatible with any of three objectives.
140							No benefits from project.
141			X				Not much potential for multiple-purpose use; Not economically justified; Too small to stimulate economy; Low potential to enhance environmental quality; Not compatible with any of three objectives.
144							Not much potential for multiple-purpose use; Not economically justified; Too small to stimulate economy; Not deemed enhancement to the environment; Not compatible with any of three objectives.
145	X		X	X			Same discussion as for site # 144.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System			PFW Plan	CC Plan	Reasons for Selection or Rejection
		EE	RD	EQ			
RESERVOIR SITES							
154							Much more expensive than alternatives; Not economically justified; Regional impact deemed more detrimental than beneficial; Would conflict with existing high quality stream; Environmental Quality deemed primary objective for this stream.
SUB-BASIN IV							
59							Low potential for multiple-purpose use; Not economically justified; Low potential to stimulate economy; Not deemed as enhancing the environment; Not compatible with any of three objectives.
64							Same discussion as for site # 59.
65	X		X				Not economically justified without regional development; Close to being justified with regional development; Low potential to enhance the environment; Environmental Quality more important than regional development for this area.
66	X			X			Not economically justified; Location would restrict growth in this area; Attractively shaped reservoir would complement its setting; Environmental Quality not deemed good enough case to select this reservoir.
67							Too big for needs in this area; Not economically justified; Low potential to stimulate economy; Would inundate attractive reach of West Branch; Not compatible with any of three objectives.
69	X			X			Good location for multiple-purpose use; Not economically justified; Low potential to stimulate economy; Attractively shaped reservoir would blend in well with environment; Not deemed a very desirable project because it is close to existing reservoirs.
71			X				More expensive than alternatives; Not economically justified; Not deemed as enhancing the environment; Recreation expansion benefit not deemed adequate to warrant investment.
74							Not as desirable as alternatives; Not economically justified; Low potential to stimulate economy; Poor configuration not deemed as enhancing the environment; Not compatible with any of three objectives.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
RESERVOIR SITES							
151							Poor location to satisfy needs; Not economically justified; Project would hurt Regional Development more than help it; Project would inundate high value scenic area; Not compatible with any of three objectives.
155		X	X		X		Poor location to meet needs; Not deemed as enhancing the environment.
SUB-BASIN V							
51							Low potential for multiple-purpose use; Not economically justified; Low potential to stimulate economy; Project would destroy high value scenic area; Environmental quality deemed primary objective for this area.
52							Low potential for multiple-purpose use; Not economically justified; Low potential to stimulate economy; Not deemed as enhancing the environment; Not compatible with any of three objectives.
53	X						Not economically justified; Low potential to stimulate economy; Not deemed as enhancing the environment; Not compatible with any of three objectives.
55							Too large and disruptive; Not economically justified; Project deemed to hurt economy more than help it; Would inundate high value scenic area; Environmental Quality deemed prime objective in this area.
132	X		X	X	X	X	Less costly than alternatives; Good location for recreation complex; Would enhance its setting; Regional Development deemed primary objective in this area. 2000
133	X		X	X	X	X	Good location for multiple-purpose use; Good location for recreation complex; Project deemed as enhancing the environment; Regional Development and Environmental Quality deemed important objectives in this area. 2020
156							No benefits; Not economically justified; Little potential to stimulate economy; Not deemed as enhancing the environment; Not compatible with any of three objectives.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
RESERVOIR SITES							
SUB-BASIN VI							
15							Not as much potential for multiple-purpose use as alternatives; Not economically justified; Area overloaded with recreation; low potential to stimulate economy; Conflicts with agricultural use of land; Not needed in this location; low potential for use.
17							Too small; less desirable than alternatives; Not economically justified; Would complement existing parks to create recreation complex; Not deemed to enhance environmental quality; Recreation on low dams deemed preferable in this area.
18							Not economically justified; Little potential to stimulate economy; Not deemed as enhancing the environment; Not compatible with any of three objectives.
19	X						Good location for multiple-purpose use; Not economically justified; Low dams more desirable to stimulate economy; Not deemed as enhancing the environment; Low dams preferred to large dams.
22	X						Less expensive than alternatives; Not economically justified; Too close to Raystown to give added stimulation; Use potential too low to warrant investment.
27							More expensive than alternatives; Not economically justified; Low potential to stimulate economy; Not deemed as enhancing the environment; Not compatible with any of three objectives.
29							More expensive than alternatives; Not economically justified; Low potential to stimulate economy; Not deemed as enhancing the environment; Not compatible with any of three objectives.
33							Valuable trout stream; Not economically justified; Low potential to stimulate economy; Not deemed to enhance the environment; Not compatible with any of three objectives.
36							Low potential for multiple-purpose use; Not economically justified; Low potential to stimulate economy; Conflict with high value fishing streams; Not compatible with any of three objectives.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
RESERVOIR SITES							
126	X	X	X				Conflict with high value fishing stream; Environmental quality deemed prime objective for this area.
129		X	X				More expensive than alternatives; Not economically justified; Not deemed *as enhancing the environment*; Regional Development potential not deemed adequate to warrant investment.
131		X	X	X			Initially considered for water supply storage; Not as efficient as alternatives after later evaluation.
SUB-BASIN VII							
12	X	X		X	X	X	Good location for multiple-purpose use; Economically justified; Amoeba-shaped reservoir would enhance environment; Area of great need for water resources development; 1980.
13							#12 is better alternative for multiple-purpose use; Not as efficient as alternative; Agricultural use deemed more important to economy; Not as desirable as #12.
14	X	X			X		Excellent recreation potential; Economically justified; Agricultural use deemed important to economy; Conflicts with aesthetic pastoral setting; Deleted because of conflict with agricultural use of land.
48							Not as much potential as alternatives; Not economically justified; Agricultural use deemed more important to economy; Conflicts with aesthetic pastoral setting; Not as desirable as alternatives.
49	X	X	X				Less expensive than alternatives; Economically justified; Close to growth centers; *Would interfere with attractive pastoral setting*; *Retaining* agricultural land prime objective in this area.
135							Low potential for multiple-purpose use; Not economically justified; Low potential to stimulate economy; Environmental quality better without large dams on river; Not compatible with any of three objectives.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
RESERVOIR SITES							
SUB-BASIN VIII							
3		X					Low potential for multiple-purpose use; Economically justified; Agricultural economy better for area; Conflicts with pastoral area; Preservation deemed primary objective in this area.
4		X					Low potential for multiple-purpose use; Economically justified; Agricultural economy better for area; Conflicts with pastoral area; Preservation deemed primary objective in this area.
5							Low potential for multiple-purpose use; Not as desirable as alternatives; Agricultural economy better for area; Conflicts with pastoral area; Preservation deemed primary objective in this area; Not compatible with any of three objectives.
8							Not as good as alternatives; Not economically justified; Could enhance economy of the area; Conflicts with agricultural use of land; Regional Development impact not deemed adequate to warrant investment.
10			X		X	X	Economically justified; Good opportunity to stimulate economic growth; Needed to meet long-range recreation and low flow needs in lower Susquehanna; 2020.
134							Not as desirable as alternatives; Marginally justified, but economic loss deemed too large; Economy better with land left as agricultural; Conflicts with agricultural use of land; Preservation deemed primary objective for this area.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
SUB-BASIN I							
48-1		X	X		X	X	This reservoir has excellent recreation and good fishing development potential capability; the site would be long and narrow, thus being somewhat less than ideal aesthetically; site here would benefit Willseyville area in future economic growth. 2000
48-2			X				A small reservoir which could be built to meet fishing needs; also this site would assist in the economic growth of the East Berkshire area; originally considered for flood prevention at Newark Valley.
48-3			X				This highly inefficient storage potential reservoir on a primary trout stream could be constructed to help Harford Mills, Richford and Berkshire in economic growth; site was originally considered for flood prevention in Newark Valley.
NY 48-4					X	X	Good quality fishing site of 303 acres on Michigan Creek, 2 miles north of the Tioga County Line, in Tompkins County; State owns most of the land; a dirt road will have to be relocated. 1980
48-5							The potential reservoir would have reduced recreation and fishing value because of its proximity to Spencer Lake; it was not considered in any plans because of its effect on transportation routes and minimal recreation area.
48-6			X	X			Site has a large reservoir but adjacent area suitable for recreation is small; reservoir here, although not suited for fishing, would help the economic development of the Candor and Spencer area; this site would lend a pleasing aesthetic note.
48-7			X				A reservoir built on this very inefficient storage potential site would help economic growth in the Willseyville, Candor and Speedsville area; this dam was considered for irrigation storage.
NY 48-1					X	X	Good quality fishing site of 35 acres on tributary to East Branch Owego Creek, in Tioga County; no relocation is necessary. 2000
NY 48-2					X	X	Good quality fishing site of 35 acres on Michigan Creek, in Tioga County; no relocation is necessary. 2000
NY 48-3					X	X	Good quality fishing site of 37 acres on Miller Creek, 2 miles north of the Tioga County Line, in Tompkins County; state owns land. 2000

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
49-1						X	A dam at this location was requested by the State of New York to satisfy fishing needs. 2020
49-2		X	X	X	X	X	Site at this location would provide partial flood control protection for Georgetown and Georgetown Station. 1980
49-3		X	X	X	X	X	This efficient storage potential site on a trout stream will provide flood protection, along with 49-2, at Georgetown and Georgetown Station. 1980
49-5							This site is located on Fabius Brook, an excellent trout stream
49-8			X	X			The fairly inefficient storage reservoir could provide partial flood protection and water supply for Homer and Cortland; irrigation storage potential is a possibility; economic expansion benefits would be realized at Scott and East Scott area; site was screened out of the planning process because of its location on an excellent trout stream; also considered for low flow augmentation to improve trout habitat in droughty months.
49-9			X				This expensive flood prevention reservoir would provide Homer and Cortland, along with 49-8, partial flood protection; by conventional methods, this project is not economically justified.
49-13	X	X		X			A potential fishing and recreation site could be developed as an alternate for NY 100; a reservoir here would provide ideal scenic contrast with the landscape.
49-14							A relatively expensive site near Triangle which would involve considerable relocations, if developed to a higher elevation.
49-15A		X	X	X	X	X	This reservoir, along with 49-34 will provide economical flood protection for the village of McGraw. 1980
49-18			X				A site here could be developed for fishing, recreation and incremental flood protection and regional expansion at Marathon; however, it could not be justified by conventional methods.
49-20							An uneconomical reservoir located on a tributary above East Homer; it may not be justified for flood protection in this area.
49-22						X	A reservoir here was requested by the State of New York to satisfy fishing needs. 1980

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
49-23		X	X	X			An upstream reservoir would benefit Lincklaen and Union Valley; however, desire to preserve Mud Creek kept this site out of the final planning steps; it was thought to be efficient for recreation, fishing, flood prevention, and irrigation, and was considered for low flow augmentation to improve the fishery during droughty periods.
49-28	X	X	X			X	This larger reservoir could meet the recreation, flow augmentation, and partial flood control for Cortland; from a regional standpoint, it could help meet the vast future recreation needs of Syracuse; this site would be more efficient than an alternate 49-32; therefore, because of the size of needs this site can meet, its lower unit cost, and its strategic location near population center, this site was chosen as part of the early action development prospectus. (Fabius Project in Appendix K(2)) 1980.
49-30			X				A large efficient recreation reservoir could be built which would also provide Pitcher, Taylor and Cincinnatus with future economic development potential; because of the shallowness of the reservoir, fishing would not be desirable at the site; stream preservation on Mud Creek kept this site out of the plan formulation process.
49-31	X						A fairly large and expensive permanent pool could be constructed which would not be suited for extensive recreation development; the site is located near the mouth of the creek, thus making it unusable for upstream flood control purposes; it was thought this site could help the water quality problem in the Tioughnioga River.
49-32	X	X	X	X	X		This reservoir could meet Cortland's flow augmentation, recreation, and partial flood control needs; the site is both smaller and more expensive, on a unit basis, than the primary alternative 49-38; this site is well suited aesthetically and would contribute to Cortlant's economic growth if built; however, the alternate site was selected based on its water storage efficiency.
49-33							This fairly large reservoir is not suited for extensive recreation development because of the steep topography; the site has a small drainage area which would limit dependable yield for full development.
49-34		X	X	X	X	X	Reservoir will provide economical flood protection, along with site 49-15A, and recreation fulfillment for the village of McGraw. 1980
NY 49-1							A fair quality fishing site of 83 acres, on tributary of Tioughnioga River, in Cortland County; state owns land but total costs are relatively high.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
NY 49-2							A good quality fishing site of 45 acres on tributary to Mud Creek, near Union Valley, in Cortland County; state owns land but total costs are relatively high.
50-1							A reservoir at this location would be competing with many natural and man-made lakes; since the site would be built in swamp area, extensive wildlife mitigation damages would occur.
50-2	X		X	X			This larger reservoir is not well suited for recreation development; Eaton, Morrisville and Hamilton would benefit by regional concepts if this were built for irrigation, recreation, an flood prevention; however, the site was screened out of the planning process because it is on a high value trout fishery.
50-4			X				A site with a small pool could be constructed to assist in economic expansion of Sherburne and Earlsville; however, this site is small, costly and would provide limited flood protection and irrigation benefits to the area.
50-5A			X				This small reservoir would benefit Smyrna through flood reduction, fishing and recreation development; however, this site did not appear justifiable.
50-6							A small inefficient reservoir investigated as one of the alternatives to South Plymouth Dam; it was originally considered for flood protection site on Canasawacta Creek.
50-7							Another small dam investigated as an alternative to South Plymouth Dam along Canasawacta Creek.
50-8						X	Small reservoir requested by the State to satisfy fishing needs and for flood protection along Canasawacta Creek. 1980
50-9							One of the many small, expensive and inefficient sites investigated during the field inventory phase; thought to be desirable recreation site for Norwich.
NY 50-4 & 50-10					X	X	Reservoir requested by the State to satisfy fishing needs. 1980
50-11							Small, expensive reservoir upstream from Tyner; was not used because of little apparent need.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
50-12							Small, relatively expensive site near mouth of stream thus making it undesirable for upstream flood control; road relocations made this site undesirable also.
50-14			X	X			A very expensive site which could help Sherburne in economic development; site is well suited aesthetically to the landscape; it was screened out of plan because of the first class trout stream which it is located on.
50-18							A small expensive site located upstream from Morrisville; it is located on a high value trout stream.
50-19							A small expensive reservoir located upstream from Preston; originally looked like a good recreation site close to Norwich, but relocations were too expensive.
50-20			X				Small expensive site which could be developed for fishing, recreation, irrigation, flood protection, and economic expansion of Earlville area; site would not be justified by current criteria.
NY 50-1					X	X	Good quality fishing site of 63 acres on tributary to Tillotson Creek, 2 miles southwest of Tyner, in Chenango County; no relocation is necessary. 2000
NY 50-2					X	X	Very good quality fishing site of 115 acres on Kedron Brook, in Chenango County; possible barn relocation. 2020
NY 50-3					X	X	Very good quality fishing site of 148 axres on tributary to Five Streams, 4 miles southeast of Pitcher, in Chenango County; state owns land; a dirt road will have to be relocated. 1980
51-2							A small, fairly expensive site located upstream from Burlington; site is located on a trout stream.
51-6							A relatively small and expensive site offering recreation and partial flood protection to Gilbertsville; road relocation cost was considered too extensive for the size of reservoir.
51-7							Expensive upstream reservoir located above Edmeston and considered for flood protection; site screened because of cost.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
51-10			X				Expensive upstream reservoir which would offer regional development benefits to Goth, Columbia Center, and Miller Mills; site would be undesirable for fishing development.
51-11			X				By regional benefits this site would help Waterville, Bridgewater and Clayville economically; the reservoir would be too shallow for good fishing potential.
51-14			X				This site was considered for regional development of Brookfield, Lenardsville, and West Edmeston; the lake would be too shallow for fishing.
51-15	X	X	X	X	X	X	A large, efficient reservoir offering fishing, recreation, flood prevention, and regional development for the Brookfield area; this site was considered desirable at all stages of plan formulation process. 1980
51-18			X				Small reservoir if developed for recreation and fishing could help Columbus area obtain regional growth.
51-19							An expensive, inefficient headwater site which could at best satisfy few water resource needs; originally considered for flood prevention on Great Brook watershed.
51-20			X				Fairly expensive site could help develop Clayville, West Windfield, and Bridgewater economies; however, the site would be too shallow for good fishing.
51-21				X			Expensive site located upstream from Arubleville would be aesthetically pleasing; site was screened out of planning process because it is located on a high value trout stream.
51-22							This small relatively expensive reservoir is located upstream from Morris and was investigated for flood prevention on Aldrich Brook.
51-23			X				A small, expensive recreation reservoir which could be developed for regional growth near South Edmeston.
51-24							Another small, expensive site located upstream from Morris.
51-25							Small reservoir located upstream from Davis Crossing; New York Conservation Department is considering development of this site.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
NY 51-1							A good quality fishing siteof 42 acres about 1.3 miles southwest of Bridgewater at the Oneida-Madison County line; no relocation is required; total costs are relatively high.
52-4				X			Expensive reservoir of medium size which would be aesthetically pleasing; this site is a much smaller alternative to Charlotte Creek development.
52-5				X			Reservoir could provide recreation and partial flood protection, along with 52-6, at Charlotteville; site originally studied for irrigation and low flow augmentation.
52-6				X			Reservoir could provide recreation and partial flood protection, along with 52-5, at Charlotteville; site originally studied for irrigation and low flow augmentation.
52-7		X	X	X			Site would provide economic development benefits through regional growth, irrigation and partial flood control to the Warcester area; site was screened out when stream was classified for preservation.
52-8		X	X		X	X	Site would provide recreation, fishing, and flood control benefits to East Warcester. 2000
52-9			X	X			Relatively expensive reservoir located upstream from Laurens and Mount Vision; site could be developed for irrigation, fishing, recreation, and flood control; site was screened out as alternative 52-12 is more efficient.
52-12	X	X			X	X	Inexpensive site ideally situated to be developed for fishing; this site produces more resource development per unit cost than its alternative 52-9, although slightly smaller in size. 2000
52-13				X			Site is located upstream from Butts Corner and would provide excellent visual contrast with the existing landscape at reasonable cost; site was screened out of planning because of stream preservation for fishing.
52-14							A fairly expensive small upstream dam above Otego; this site is not as well suited for extensive development as its alternative 52-15; east Branch Otsdawa Creek is a fishing stream.
52-15	X	X		X	X	X	This highly efficient dam would provide fishing opportunity and partial flood protection for Otego; the reservoir is more suited for development than an alternative site 52-14. 2000

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
NY 52-1						X	Fair quality fishing site of 82 acres on tributary to Schenevus Creek at Bear Swamp Pond in Otsego County; state owns land. 1980
NY 52-2							A good quality fishing site of 67 acres on tributary of West Branch Otego Creek, about 4 miles west of Hartwick, in Otsego County; state owns land but total costs are relatively high.
53-1				X	X	X	A highly efficient water storage potential reservoir; in fact, the second best of this sub-basin; this site could satisfy part of the fishing and recreation needs in the area; because of its size, this site makes only a small contribution to economic development of the area; this site, along with 53-2 and 53-3, is an alternative for the major reservoir on Cherry Valley Creek. 2000
53-2		X		X	X	X	This site is the largest upstream reservoir investigated on Cherry Valley Creek; it is relatively efficient in water storage and could be developed for flood control, fishing and recreation areas; this site with 53-1 and 53-3, is an alternative for the major reservoir on Cherry Valley Creek. 2000
53-3	X	X	X	X	X	X	This site could be economically developed for recreation, fishing and flood control; the site would lend itself to region type development in helping both Cherry Valley and Roseboom grow economically; site 53-4 would be a less efficient alternative for this site; this site, along with 53-1 and 53-2, is an alternative for the major reservoir on Cherry Valley Creek; the upstream sites in this area will blend aesthetically into the already beautiful countryside. 2000
53-4							This small and expensive site would be very inefficient in satisfying water resource needs; this site was an alternative to 53-3.
53-5							Shadow Brook feeds directly into Otsego Lake; even though this site is relatively efficient in water storage, its alternative site 53-6 happens to rank number one in overall efficiency in this sub-basin.
53-6				X	X	X	Trout Brook feeds directly into Otsego Lake; a fishing and recreation lake here would complement one another in providing recreators with a choice; this site is aesthetically well suited and it is the best site for storage potential; site 53-5 would be an alternative, although it is located on a different stream. 1980

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
53-7				X			This fairly large upstream reservoir could provide a vast amount of recreation opportunity; it is located centrally between Otsego and Canadarago Lakes; this could be developed to make a large recreation complex in the area; however, this site was screened out of the planning process because of stream preservation desires.
53-8			X		X	X	Hyder Creek is a direct tributary of Canadarago Lake; a reservoir constructed at this water storage site could be developed for fishing and recreation; the area of Richfield and Richfield Springs would benefit regionally if this site were built. 2000
NY 53-1							A very good quality fishing site of 110 acres on Herkimer Creek, 4 miles southwest of Richfield Springs, in Otsego County; a portion of town road would have to be located; costs are relatively high.
027-1							This small relatively inexpensive reservoir would satisfy only a few water resource needs; this site was removed from the planning process when stream preservation was considered.
027-4			X				This medium sized, but very expensive, reservoir site could be developed to help Standfordville and Brookdale in regional economic growth; this site may not be justifiable using conventional evaluation methods; Snake Creek is classified for preservation.
027-6		X	X	X	X	X	This smaller but somewhat expensive site located near Binghamton was incorporated into the planning process to satisfy the recreation and fishing needs; a reservoir at this location would complement run-of-the-river recreation and fishing use for the populated Binghamton area.
027-10		X					This small but expensive site could be developed for recreation to satisfy Binghamton's needs; the small size and unsuited topography rule out extensive recreational development.
027-11		X					This is one of the most expensive sites for water storage in the entire sub-basin; steep topography and small size eliminated this site as a possible solution for satisfying the extensive recreation needs of Binghamton.
NY 27-1					X	X	Very good quality fishing site of 38 acres on Mutton Hill Pond, 1 mile west of Appalachin, in Tioga County; no relocation is necessary. 2000
028-1						X	A small upstream reservoir requested by the State to satisfy fishing needs. 2020

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
028-2				X			A small fairly efficient upstream site; this site would be aesthetically suited to fit into the area's landscape; since the reservoir would be over a swamp, considerable wildlife mitigation damages would be expected.
028-3							This fairly efficient storage potential site is located upstream from Page Lake; this nearness would minimize beneficial use of the site.
028-8							A small upstream site located very close to many small natural lakes in Susquehanna County; the need for a small reservoir here is nullified.
028-9			X				This site, along with 028-10, would provide flood control on Drinker Creek at Susquehanna; the site may not be justified using conventional evaluation methods.
028-10			X				This site, along with 028-9, would provide flood control on Drinker Creek at Susquehanna; the site may not be justified using conventional evaluation methods.
029-1							A very expensive upstream reservoir which would require some resident relocations at Masonville; site would provide protection, but may not be justified at Bennettsville.
029-2							This site, along with 029-3, would give flood protection to Masonville; site may be unjustified.
029-3							This site, along with 029-2, would give flood protection to Masonville; site would be unjustified.
NY 30-4 & 030-2	X	X	X	X	X	X	A fairly efficient upstream site which could meet the area's fishing needs economically; in the regional development program, flood control for Yalesville Brook was added as a purpose, although this could not be justified by conventional evaluation methods. 2020
030-3							A fairly expensive small reservoir located on Wilkins Brook, a tributary of Kelsey Creek; although this site is better than an alternate 030-4, it is still too expensive for economical development.
030-4							An expensive small upstream site; an alternate 030-3, although more efficient, is also too costly for development.
030-5						X	A small upstream fishing site requested by State to satisfy needs; this site is an alternate for site 030-10. 2020

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
030-6							A small, expensive upstream site which may not meet the water needs economically.
030-7							A small, expensive upstream site which may not satisfy the needs economically.
030-8							A small, expensive upstream site which may not satisfy the needs economically.
030-9A			X		X	X	A small upstream reservoir site which could satisfy part of Binghamton's recreation needs; this site would also give flood control benefits on Still Creek. 1980
030-10							A small, expensive upstream site which may not satisfy the needs economically.
NY 30-1					X	X	Fair quality fishing site of 38 acres at Mud Pond in Broome County; no relocation is necessary. 2000
NY 30-2							This site was eliminated because it is located outside the Basin.
NY 30-3					X	X	Very good quality fishing site of 180 acres on tributary to Shapley Brook, 4 miles south of Oxford, in Chenango County; state partially owns the land; a minor road will have to be relocated. 1980
031-2			X		X		An excellent potential recreation development site on the outskirts of Binghamton; a site at this location would complement run-of-the-river recreation in the greater Binghamton area.
031-3							A small upstream reservoir which could satisfy recreation and fishing needs in the Binghamton area; site was screened out of the planning process because Nanticoke Creek is an operational P.L. 566 watershed.
031-4							A small, very expensive upstream reservoir which could help satisfy future Binghamton area recreation needs; site was screened out of planning process because Nanticoke Creek is an operational P.L. 566 watershed.
031-5							An expensive site located near mouth of Little Nanticoke Creek which is unsuitable for upstream flood protection; site would produce a rather small hard to fully develop recreation lake.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
NY 31-1					X	X	Fair quality fishing site of 32 acres on Barnes Creek in Tioga County; no relocation is necessary. 2020
NY 31-2					X	X	Very good quality fishing site of 159 acres on tributary to Crocker Creek, 4 miles northwest of Union Center, in Tioga County; mostly state owned land with no relocation necessary. 1980
NY 31-3					X	X	Good quality fishing site of 44 acres on Glen Castle Creek, 4 miles above Hinmans Corner, in Broome County; no relocation is necessary. 2000
NY 31-4					X	X	Good quality fishing site of 63 acres on Nanticoke Creek, 4 miles north of Nanticoke, in Broome County; state owns land. 1980
NY 31-5					X	X	Fair quality fishing siteof 41 acres on tributary to Nanticoke Creek, in Broome County; no relocation is necessary. 2020
032-1							A small but expensive site located near the mouth of Ellis Creek; site would not be suitable for extensive recreational development.
032-2						X	Small upstream reservoir requested by State to satisfy fishing needs. 2000
032-4				X			A fairly inexpensive upstream reservoir of moderate size; this site if developed could help Candor and Spencer in regional economic development; the site is the third least expensive site per unit of water storage in the sub-basin and blends aesthetically into the area's landscape.
NY 32-1					X	X	Very good quality fishing site of 50 acres on tributary to Pipe Creek, 4.5 miles northwest of Owego, in Tioga County; road relocation is necessary. 2000
NY 32-2					X	X	Very good quality fishing site of 58 acres in Dachman Swamp in Tioga County; possible house relocation. 2020
011-9			X				A relatively large but extremely expensive upstream reservoir; construction of this site would require considerable residential relocations in the Windham area; a reservoir built at this location would help the regional economic growth of Windham, Nichols, North Orwell, and Warren Center area; this site may not be justifiable by using conventional evaluation methods.
NY 11-1					X	X	Small upstream reservoir requested by State to satisfy fishing needs. 2000
T-2						X	Small upstream reservoir; Part of Charlotte Creek Complex. 1980

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
SUB-BASIN II							
42-1			X	X			An expensive, small upstream reservoir which was considered as an alternative source of water supply for Fassett, Pennsylvania; this site could be developed for regional aid; however, a lower cost alternate source of water supply kept this one out of the prospectus.
42-2							This relatively small upstream reservoir with low potential for regional economic development of the Daggett, Dunning, and Fassett areas; this site would not be justified using conventional evaluation methods.
42-3			X	X			This site was considered as an alternative source of water supply for Daggett and Mosherville throughout plan formulation; since this site did not lend itself suitable for extensive recreational development, another lower cost source of water supply was used in the prospectus.
42-6							A fairly large but expensive site not suited to extensive recreational development.
42-7							An extremely expensive flood control site located to protect part of Millerton; this site would not be economically justified.
43-1							A fairly large upstream site not suited for extensive development; site would be extremely costly.
43-2							A fairly expensive site located upstream from Tyrone, N.Y.; its alternative 43-3, could be constructed at a much lower cost.
43-3			X		X		A very efficient site which could be developed for fishing and recreation to complement Lake Lamoka and Lake Waneta; an alternative site, 43-2, would be more expensive.
43-4							A large upstream reservoir which would be an alternative to the major dam located on Mud Creek.
43-5	X		X				A fairly large upstream site unsuited for intensive recreational development; this site is poorly located to offer significant flood protection; however, this site would offer good fishing opportunity.
43-6		X	X	X	X		A very efficient reservoir located upstream from Prattsburg; this site could be built with extensive recreational development; the aesthetically pleasing site could aid in the regional development of the area; a site at this location would not be suited for fishing development.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
43-11			X	X	X		This large upstream reservoir is excellently located for flood protection and assisting regional development in the Bath area; site would not be suitable for extensive recreational development, but would be all right for fishing; sites 43-12 and 43-13 are alternatives.
43-12							A large upstream site suitable located for flood protection development, but poorly suited for other types of development; alternatives would be 43-11 and 43-13.
43-13							An upstream reservoir located for flood protection, but not suited for recreational development; alternative sites would be 43-11 and 43-12.
NY 43-1							An inefficient upstream reservoir investigated for fishing potential.
NY 43-2							A large reservoir investigated for fishing potential; equal facilities could be provided at a lower cost at other locations.
44-1							An expensive, small upstream site not suited for extensive recreational development; an alternate to this site would be 44-10.
44-3			X		X	X	A fairly small upstream site suited for recreational and fishing development and will provide flood control on Tracy Creek at Rathbone, N.Y.; this site is an alternative to Tuscarora Reservoir. 2000
44-4		X	X		X	X	An efficient, aesthetically pleasing site capable of being developed for recreational and fishing use; this site is one of many upstream sites which would collectively be an alternative to Tuscarora Reservoir. 1980
44-5			X		X	X	A fairly small upstream reservoir suitable for fishing and recreational development in lieu of Tuscarora Reservoir; this site would help reduce the flood hazard on its tributary. 2000
44-6			X		X		This site was considered to give surface water supply and regional development benefits to Hornell; however, the alternative of ground water was much lower in cost and capable of yielding adequate supply.
44-7		X			X	X	A small upstream reservoir requested by the State to satisfy the area's fishing needs; this site is one of several upstream reservoirs which collectively are an alternative to Tuscarora Reservoir. 1980
44-8		X			X	X	A small upstream reservoir requested by the State to satisfy fishing needs; another one of Tuscarora Reservoir alternatives. 2000

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System			PFW Plan	CC Plan	Reasons for Selection or Rejection
		EE	RD	EQ			
UPSTREAM RESERVOIR SITES							
44-9		X			X	X	A small upstream reservoir requested by the State to satisfy the area's fishing needs; an alternative to Tuscarora Reservoir. 2000
44-10							An inefficient, expensive small lake not suited for recreational development; an alternate to this site is 44-1.
NY 44-1						X	A small upstream reservoir requested by the State to satisfy the fishing needs; this site is one of many as alternatives to Tuscarora Reservoir. 1980
NY 44-2							An inefficient upstream reservoir investigated for fishing potential.
44-5							An inefficient upstream reservoir investigated for fishing potential.
46-1	X	X	X	X	X	X	An upstream reservoir with excellent potential for extensive recreation and fishing development; this aesthetically pleasing site would also enhance the economy of Blossburg and Canton if constructed for regional development purposes; this site is an integral part of the Upper Tioga River P.L. 566 watershed. 1980
46-2		X	X	X	X	X	A large upstream reservoir which could significantly reduce the flooding hazard at Blossburg, Covington, Canoe Camp, and other areas along the Upper Tioga River; this site is an integral part of a P.L. 566 watershed; fishing development would not be desirable at this reservoir. 1980
46-5A	X				X	X	A large upstream reservoir located near the mouth of Mill Creek; this site has potential for recreational and fishing development; a recreation lake here would be developed to complement Tioga-Hammond Reservoir. 2020
46-7				X	X	X	This site is the most efficient upstream site for water storage in this sub-basin; this relatively small reservoir would be suitable for fishing and recreation development; a site here would blend well into the topography. 2000
46-10				X	X	X	A fairly efficient upstream site with good recreation development potential; this reservoir would be aesthetically enhancing to the area if constructed; this site could satisfy most of Mansfield's water, recreation, and fishing needs. 2000
46-14			X				A small, extremely expensive upstream reservoir not suited for extensive recreational development; this site is an alternate source of water supply for Mansfield; this site is also an alternate flood control reservoir on a P.L. 566 watershed.

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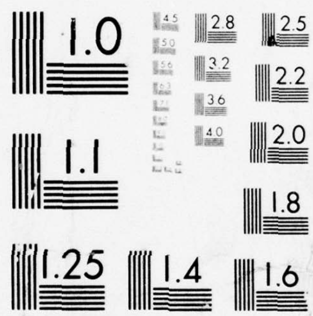


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
46-15		X	X	X	X	X	An integral part of a P.L. 566 flood protection project to reduce flooding at Blossburg and along the Upper Tioga River Valley. 1980
46-16		X	X	X	X	X	This site is an integral part of a P.L. 566 project on Upper Tioga River; in addition to flood control, it is also an alternate source of water supply for Blossburg and other communities; there is a run-of-the-stream water supply pickup currently located near where this site would be built. 1980
012-1			X	X	X	X	A flood control, fishing, and recreational development lake on Bentley Creek; this site would furnish partial flood protection at Wellsburg; also, construction of this site would help regional development of the area's economy. 1980
012-3			X				A single purpose flood control structure on Bentley Creek watershed which would be unjustified using conventional evaluation methods.
012-4			X		X		
012-5			X		X		A single purpose flood control structure on Bentley Creek watershed which would be unjustified using conventional evaluation methods.
012-6			X		X		A single purpose flood control structure on Bentley Creek watershed which would be unjustified using conventional evaluation methods.
012-7			X		X		A single purpose flood control structure on Bentley Creek watershed which would be unjustified using conventional evaluation methods.
012-8			X		X	X	A flood control and recreational development lake on Bentley Creek; this site would furnish partial flood protection at Wellsburg, N.Y.; construction of this site would help regional development of the area's economy; This site would not be desirable for its fishery aspects. 1980
012-9			X		X		A single purpose flood control structure on Bentley Creek watershed which would be unjustified using conventional evaluation methods.
012-12			X				A small relatively inefficient upstream reservoir selected to help the Athens and Sayre area regional development and fishing aspects.
012-13			X		X		A single purpose flood control structure on Bentley Creek watershed which would be unjustified using conventional evaluation methods.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
033-1			X		X	X	An upstream reservoir which is suitable for extensive recreation and fishing development; this site could satisfy a portion of the Elmira and Waverly recreation needs; also, a structure at this location would enhance the regional development prospects of Beantown, Chemung and Chemung Center. 1980
033-2	X		X				A small efficient upstream reservoir which is being formulated as part of the Newtown Creek-Hoffman Brook P.L. 566 watershed project.
NY 33-3						X	A small upstream reservoir requested by the State to satisfy the area's fishing needs. 1980
034-1							A small upstream reservoir which is being formulated in conjunction with a P.L. 566 project on Newtown Creek and Hoffman Brook.
035-1						X	A small inefficient site not suited for extensive recreational development. 1980
035-2			X	X	X		A relatively efficient water storage site which could help develop the Caton area regionally; this site could satisfy part of Elmira-Corning area water-oriented recreation needs as well as some of their fishing needs.
035-3							This small upstream site has topography which is too steep to be suitable for recreational development.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
<u>SUB-BASIN III</u>							
34-1							An upstream reservoir suitable for fishing development that was primarily investigated for flood prevention at Mainville; however, the expense of this site may be too great for economic justification.
34-2			X				A fairly small and expensive upstream site which could not be developed for fishing or recreation use because of the acid stream; if site were developed it would help Mifflin Crossroads and Scotch Valley areas grow from a regional point of view.
34-3		X			X	X	A small upstream site which could reduce the flood hazard at Shumans and also be developed for multiple purposes by having recreation and fishing included. 1980
34-4							The site is located downstream from some active strip mining activity.
34-8			X				A small upstream reservoir at this location could assist Ringtown growth through regional economic development; the site was screened out of planning process because it is located on an excellent trout stream.
34-9		X			X	X	A small upstream reservoir studied to prevent flooding to a trout hatchery along Crooked Creek. 1980
35-1							A small upstream site located on a swamp just north of St. Johns; high cost of mitigating wildlife damages keeps this site out of plan.
35-2	X	X	X	X			This large, efficient upstream reservoir could be developed for flood reduction at Angila Park and St. Johns as well as extensive recreational and fishing development; the site is ideally located near the intersection of Interstate Route 80 and 81; the site was removed from plan formulation when a P.L. 566 watershed on Nescopeck Creek was approved for work plan development.
35-4							A site at this location is both smaller and more expensive per unit of storage than its alternative site 35-2; also, a site here would not offer the flood prevention potential.
35-5							This expensive, small upstream site may be competitive in satisfying water needs of the area.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
36-1		X					An upstream site which would be an expensive water storage reservoir.
36-2		X					An upstream site which would be an expensive water storage reservoir.
36-3							An upstream site which would be an expensive water storage reservoir.
36-4A							A large reservoir with steep slopes making it unsuitable for extensive recreational development.
36-5							An expensive upstream reservoir involving considerable relocations.
36-6							A small upstream site which would be quite expensive to develop.
36-7A							A very expensive site located just upstream from its alternative site 77.
36-8							A fairly large reservoir which can store water at about average unit cost; this site has fairly steep topography on the right abutment, thus limiting the extent of recreational development potential.
36-9							A smaller downstream alternative to 36-8.
36-10			X	X			A fairly small site capable of being developed for fishing and recreation purposes which could also benefit Red Rock and Mossville areas through regional growth.
36-12							Another medium-sized upstream reservoir site which has steep topography on the left abutment that would limit extensive recreational development; a site at this location would be partially effective in reducing the flooding hazard on Little Fishing Creek; this site is not suited for fishing.
36-13B	X	X	X		X	X	A very large and efficient upstream reservoir capable of being developed extensively for recreation and fishing purposes; such a site would help the economic growth of Rohrsburg and Orangeville area; the site would handle a large portion of Sub-basin III growing water needs. 1980
37-9							An intermediate-sized upstream site with potential for recreational and some flood reduction development.
37-14							A small upstream site which would be extremely expensive to develop.
37-15							Another small upstream site which would be expensive to develop.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System			PFW Plan	CC Plan	Reasons for Selection or Rejection
		EE	RD	EQ			
UPSTREAM RESERVOIR SITES							
37-16		X					A fairly efficient upstream site which has a smaller than desirable minimum drainage area for extensive recreational development; this site along with its alternative 37-20 would make suitable fishing sites.
37-20	X		X	X	X	X	A fairly large site suitable for recreation and fishing development; the site was considered for water storage to provide low flow augmentation for EQP; a site at this location would not include flood reduction storage since it is upstream from Still Water Reservoir. 1980
37-30							A site on Hull Creek could help reduce the flooding hazard at Blakely; the flood damages from Hull Creek could be completely eliminated if this site along with an improved flood channel were installed; also, this site could be developed for recreational use.
38-5			X				A fairly large and efficient upstream site which could be developed for water supply, flood prevention, and recreational use; a site at this location would add to the regional growth prospect of Factoryville area; this site was screened out of the project formulation process because of desire to preserve the stream for fishing.
38-6		X	X	X	X	X	The site would be the only structural measure needed to provide adequate flood control at Clifford; Dundaff Creek would qualify as a P.L. 566 watershed; the site has the potential of being developed for recreation and fishing use in addition to the flood prevention purpose; also, this aesthetically pleasing site would be helpful in assisting the area's future growth. 1980
38-9	X						This site was screened out of project formulation because the State is constructing a fishing reservoir at this location.
38-10		X				X	An upstream reservoir well suited for its fishery development potential; the site is located near Interstate Highway 81. 1980
38-11							A fairly small upstream site which has steep topography on the left abutment, thus limiting its potential as a recreation site.
38-15							A very small upstream reservoir located on a small swamp; wildlife mitigation damages would be a limiting factor in developing this site.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
38-16			X				A small efficient upstream reservoir site capable of being developed for its fishery potential; the site is located on a small swamp which would result in mitigating wildlife damages; a site at this location would be beneficial to the Brooklyn and Hop Bottom area.
38-17			X				Another small upstream site located on a swamp; due to its shallowness, this site would not be suitable for fishing; also, its nearness to Lake Carey would minimize any beneficial effects; if built, this site would benefit the Tunkhannock area.
38-18							A fairly small and inefficient upstream reservoir site located in a swampy area.
39-1				X	X	X	A site of average efficiency for water storage that is well suited for recreational and fishing development; the site is located near Montrose and would serve many of its water needs. 2000
39-3		X					A medium-sized upstream reservoir with steep side slopes which would limit the recreational development potential of this site; the reservoir would be suitable for fishing.
39-4							A very expensive upstream site that would be suitable for fishing but its recreation potential is limited by the steep side slopes; this site, along with sites 39-3 and 39-10, would be an upstream alternative to the reservoir site at Stevensville.
39-6							A very expensive and small upstream site located near Forest Lake.
39-10			X			X	A fairly large upstream lake suited for recreational development; such a lake would complement the several small natural lakes in the area; this dam would benefit LeRaysville and Lawton area through region economic development. 2000
39-11			X	X			A small and expensive upstream site which could help the Rush and Lawton areas in regional growth; this site would be aesthetically pleasing.
40-1			X		X	X	A small upstream site which can offer partial flood prevention along the creek and satisfy the recreation needs of the Monroeton and Liberty Corners; site at this location would be suitable for fishing. 2000

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
40-2							A small upstream reservoir along with sites 40-3, 40-4, and 40-5 could offer partial flood protection to New Albany.
40-3							A small upstream reservoir which, along with sites 40-2, 40-4, and 40-5, could be built for partial flood protection of New Albany.
40-4							A small upstream reservoir which, along with sites 40-2, 40-3, and 40-5, could offer partial flood protection for New Albany.
40-5							A small upstream reservoir which, along with sites 40-2, 40-3, and 40-4, could be built for partial flood protection of New Albany.
40-7							A very expensive upstream reservoir with steep side slopes which makes the site unsuitable for extensive recreational development; the site could meet Powell's water supply needs.
40-8		X					A large but expensive site capable of supplying Leroy water supply needs and the Canton area recreational needs; extensive relocations and cost make this site less desirable.
40-10	X						A fairly small site which would not be needed if site 46-1 were to be constructed on Upper Tioga River.
41-1							A fairly small reservoir site located near the State Park now under construction; a site here could include fishing as a purpose.
41-2							A fairly small reservoir site located near the State Park now under construction; this site could be developed for fishing.
41-4							A small expensive upstream reservoir which would have steep slopes making it unsuitable for extensive recreational development; however, fishing could be developed in a site at this location.
41-7	X		X		X	X	A fairly large site well suited to fishing and recreational development; a site here would satisfy most of the Troy area needs. 1980
41-8							A smaller and more expensive on unit basis of water storage upstream alternative to site 41-7.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
41-9			X	X			A medium-sized upstream reservoir which could be developed for fishing and water supply; the site would satisfy needs in the Columbia Cross Road and Troy area; steep slopes would limit the reservoir recreational potential.
41-10		X		X			A small upstream reservoir capable of being developed for fishing and recreational use.
41-11							A small and expensive upstream reservoir capable of being developed for fishing and recreational use.
06-1							A very small and expensive upstream reservoir site capable of partial flood protecting Kline Grove.
06-6			X	X	X	X	An upstream reservoir which, along with sites 06-7 and 06-8, could provide partial flood protection along Roaring Creek; this site would be suited for fishing and recreational development. 1980
06-7			X	X	X	X	An upstream reservoir which, along with 06-6 and 06-8, could provide partial flood protection along Roaring Creek. 1980
06-8			X	X	X	X	An upstream reservoir which, along with 06-6 and 06-7, could provide partial flood protection along Roaring Creek; the site could also be used for fishing and recreational purposes. 1980
07-1							Small upstream site which could be developed for fishing or recreation; site would satisfy most of the water needs in the Lime Ridge area.
07-2							A small upstream reservoir suitable for recreational development.
07-3A							The most expensive site investigated in this sub-watershed area; the site could be developed for recreational use; the site would be an alternate to the large reservoir on Wapwallopen Creek.
07-5							A very small upstream reservoir site in the Lindeburg area.
07-6							A fairly small upstream reservoir site which would be an alternate to site 07-7.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
07-7			X		X	X	A very efficient medium-sized upstream reservoir capable of being developed for extensive recreational use and offering partial flood protection along Wapwallopen Creek; the site is located on a stream now suited for trout fishing; a recreation site at this location would complement Nescopeck Creek reservoir and together with Nescopeck could meet much of Wyoming Valley's needs. 1980
07-8			X		X		A medium-sized upstream site ideally located for extensive recreational development; however, Andy's Pond, located just upstream, is a Luzerne County park site currently being developed.
07-9							A small but efficient upstream site which could be developed for recreational use; this site could be used for fishing.
07-10							A small but only fairly efficient storage reservoir site in the Slocum area.
07-11							Another small and efficient upstream reservoir site.
Andy's Pond						X	A reservoir located just upstream from 07-8 currently being planned as a part of Luzerne County Park System; the site is ideally located in relation to Interstate Highway 81 which would provide excellent access to all the Wyoming Valley residents. 1980
08-1							A small fairly efficient reservoir which could satisfy some of Wyoming's needs.
08-3							A very efficient upstream reservoir located on Harveys Lake outlet whose water quality would detract from the site's usefullness; a site here could be developed in conjunction with Harveys Lake to form a recreational complex to satisfy some of the Wyoming Valley needs.
08-4	X	X	X	X	X	X	A larger reservoir site well suited for both recreation and fishing development; the site is in Wyoming Valley and located to handle a great deal of the needs; besides being fairly large, the site is efficient, aesthetically pleasing, and would aid the regional growth of the area. 1980
08-5			X				A small efficient upstream reservoir suited for limited recreation and fishing development.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
08-6		X					A small efficient upstream reservoir located midway between three cornered Pond and South Pond.
08-8							A relatively inefficient and small upstream reservoir located near Koonsville.
08-9		X	X		X	X	The most efficient water storage site in the entire sub-basin which is capable of being developed for recreation and fishing needs; the potential site could help Shickshinny through regional growth aspects; since the reservoir would be located in the Wyoming Valley, there could be good access to the site. 1980
08-10							A somewhat less efficient and small upstream alternative to site 08-9.
08-11							An average site for water storage efficiency with a small beneficial reservoir pool size which would be ideally located midway between Berwick and Bloomsburg.
PA 499			X	X	X	X	A small upstream reservoir site extremely well suited for wildlife development; a single purpose site was proposed at this location as a part of the P.L. 566 watershed project on Briar Creek. 1980
09-1			X				A small upstream reservoir located between Wyalusing and New Albany; the long, narrow and fairly efficient reservoir area would be suited for both recreation and fishing use.
09-2						X	A relatively efficient upstream reservoir located between Noxen and Ruggles; this site is suitable for fishing and recreational development; considerable wildlife mitigation of damages would result from constructing a dam located on this mountain top swamp. 2000
010-1							A fairly large expensive upstream reservoir site which has steep slopes limiting its recreational development potential; the site is suitable for fishing use.
010-2	X		X				A site at this location would result in a larger permanent pool than its downstream alternative, site 010-1; steep topography makes this site not well suited for extensive recreational use; fishing would also be somewhat limited; however, a site here could help the Springville area considerable through regional economic growth.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
010-3							A very small and expensive upstream reservoir.
010-6		X					Another small and relatively expensive upstream reservoir site near Auburn Center.
010-7			X				A small upstream reservoir which could be used for recreation and fishing; a site here would provide flood protection along Riley Creek.
010-9		X				X	A small upstream reservoir well suited for fishing development; the site is included as part of the prospectus to meet the needs. 202
010-10							An inexpensive but small site located between Spring Hill and Laceyville; the nearby Susquehanna River would reduce the value of this site for recreation and fishing use.
010-11							A small and inefficient storage site not well suited for either recreation or fishing.
010-12			X				A small fairly efficient site which could be developed for fishing needs; a site here could assist Newton Center in regional economic growth.
010-13							A long, narrow and small upstream reservoir site which is more expensive than its alternative, site 010-15.
010-14		X					A small efficient reservoir site near Lake Winola.
010-15			X		X	X	A small pool but very efficient water storage site located midway between Pittston and Tunkhannock; both fishing and recreational development could be utilized here; a recreation development here would take advantage of the area's great natural beauty, clean streams, and its nearness to a large population. 1980
010-18							A small permanent pool on an extremely expensive reservoir site couple to make a dam undesirable here; also, the site would have steep slopes that limit its use for recreation; however, the site could be utilized for fishing purposes.
011-1		X				X	A small upstream site well suited for fishing use. 2020
011-3			X				A small fairly efficient upstream reservoir located near Standing Stone; this site could be developed for fishing purposes or regional development.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System			PFW Plan	CC Plan	Reasons for Selection or Rejection
		EE	RD	EQ			
UPSTREAM RESERVOIR SITES							
011-4				X			An upstream site which could provide water supply, partial flood protection, and irrigation water along Wysox Creek.
011-5			X	X	X	X	An efficient upstream site suited for recreation and fishing development; this site could offer partial flood protection along Wysox Creek. 1980
011-6				X			A small upstream site that blends aesthetically into the countryside; a site here would offer partial flood protection along Wysox Creek.
011-7							A small, expensive upstream site located near the Susquehanna River; even though this site is suited for fishing, its value would be diminished because of its location.
019-1							A small dam near junction of Susquehanna River and the West Branch; a dam at this location could give partial flood protection to Lithia Springs and offer fishing potential.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
SUB-BASIN IV							
18-1A							A large upstream reservoir located near mouth of Black Moshannon Creek unsuitable for flood control or extensive recreational development; site was considered for potential storage of flood runoff to prevent excessive mine acid overflow.
18-3			X		X	X	This upstream reservoir could be built as a source of water supply for Philipsburg, since it is located on one of the few local streams in the area not being affected by mine acid pollution. 1980
18-5			X	X	X	X	An upstream reservoir ideally located for a recreation complex in conjunction with Black Moshannon Dam and Black Moshannon Airport; the airport would be located on a ridge overlooking both reservoirs; this recreation complex would service State College and Philipsburg areas; the site would be aesthetically pleasing as it would have several branches and bays on the lake. 2000
18-6		X	X		X	X	This efficient upstream reservoir is suited for extensive recreational and fishing potential development; such a site would help satisfy the Philipsburg recreation area need; this site, along with sites 18-7, 18-15, and 18-16, was considered as possible flood control measure to protect Osceola Mills and Philipsburg the flood channel now under construction at Philipsburg makes further flood control measures unnecessary. 2000
18-7							This site was investigated primarily for acid mine water storage during excessive overland runoff periods; however, this use was shown to be infeasible this site is also an alternate flood control measure for Osceola Mills and
18-8							This site was investigated primarily for acid mine water storage during periods of excessive overland runoff; however, this use was shown to be infeasible.
18-9							This site was investigated primarily for acid mine water storage during periods of excessive overland runoff; however, this use was indicated to be infeasible.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System			PFW Plan	CC Plan	Reasons for Selection or Rejection
		EE	RD	EQ			
UPSTREAM RESERVOIR SITES							
18-11							This site was investigated primarily for acid mine water storage during periods of excessive overland runoff; however, this use was shown to be infeasible.
18-12							This site was investigated primarily for acid mine water storage during periods of excessive overland runoff; however, this use was shown to be infeasible.
18-13		X					This site, located downstream from Albert Run which empties into Little Laurel Run, was investigated primarily for acid mine water storage during periods of excessive overland runoff; however, this use was shown to be infeasible.
18-15			X	X			This site was investigated primarily for acid mine water storage during periods of excessive overland runoff; however, this use was shown to be infeasible; also, the site is an alternate measure for flood control at Osceola Mills and Philipsburg.
18-16							This site was investigated primarily for acid mine water storage during periods of excessive overland runoff; however, this use was shown to be infeasible; also, the site is an alternate measure for flood control at Osceola Mills and Philipsburg.
19-1		X	X	X	X	X	A fairly large and efficient water storage potential upstream reservoir well suited for extensive recreational development; such a recreation lake would complement the Prince Gallitzin State Park located about 10 miles north of 19-1; this site will be needed to satisfy part of Altoona's recreation needs; the site is especially well adapted to the topography with two main branches and several fingers on the reservoir. 1980
19-5							An expensive upstream site in that the topography is too steep for recreational development; a site at this location would satisfy few other water resource needs; this site is located midway between Prince Gallitzin State Park and Curwensville Reservoir.
19-7							A somewhat efficient upstream reservoir located in terrain unsuited for extensive recreational development.
19-9							A small upstream reservoir which could be developed for recreational use; this site is an alternate flood control measure for Smoke Run and Madera.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
19-10							A very efficient water storage upstream reservoir which could be developed for extensive recreation use after Hasslett Run mine acid problem is cleaned up; this site could contribute to the regional growth of Mahaffey area when it is constructed.
20-1			X		X	X	An efficient upstream reservoir with potential for stimulating economic growth of the region; a site here would satisfy recreation and fishing needs. 2020
20-2							An expensive upstream site which is not presently needed to satisfy the region's water resource needs.
20-3		X		X			This small upstream site is aesthetically adapted to the surrounding topography and could be developed to satisfy recreation and fishing needs.
20-5		X					This long, narrow and very efficient storage site could satisfy some of the area's water resource needs; several roads would need to be relocated in the Glen Campbell area if this site is to be built.
20-6							A relatively small upstream structure investigated as a possible flood control measure on Anderson Creek; this site is a smaller alternate for 20-7.
20-7		X	X	X	X	X	A fairly efficient upstream reservoir capable of extensive recreational development; this aesthetically pleasing location would satisfy part of the recreation needs of Clearfield and Curwensville; a site here would have an alternate purpose of flood control on Anderson Creek. 1980
20-9			X	X			This ideally located, efficient and aesthetically adaptable reservoir could be constructed to meet some of the area's recreational needs; however, site 20-11, an alternative, is larger and less costly; site 20-11 is the most efficient water storage site in the headwaters of the sub-basin.
20-10			X				This small upstream structure could contribute to the regional development of the Grout, Bowertown and Hillsdale area; a site here may not be justified using conventional evaluateion methods.
20-11		X	X	X	X	X	This highly efficient upstream reservoir, best site in Sub-basin IV, is readily suited for recreation and fishing development; the site is located near Barnesboro, Patton, and Westover and could help the area through regional development; the site has two main branches and several fingers which makes it adaptable with the topography. 1980

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
20-12			X	X			This fairly efficient reservoir could be developed for flood protection at Patton and regional growth in the Patton, Bradley Junction, and Driscoll area; a site here would blend pleasingly with the countryside; however, this site was screened out of plan formulation because of its proximity to Prince Gallitzin State Park.
20-13							This small upstream site was considered as an alternative flood prevention measure to protect the Patton area; site could not be justified for this purpose.
20-14							
20-15							Another small upstream site considered as an alternative flood prevention measure to protect the Patton area; site could not be justified for this purpose.
20-16							Another small upstream site considered as an alternative flood prevention measure to protect the Patton area; site could be justified for this purpose.
20-18							Small upstream site considered as an alternative flood prevention measure to protect the Patton area; site could not be justified for this purpose.
25-1A							An expensive upstream site with steep slopes making it unsuitable for extensive recreational development; site is located upstream from the Bush Reservoir.
25-2			X				An expensive upstream site with steep slopes making it unsuitable for extensive recreational development; site is located upstream from the Bush Reservoir.
25-1D							A low cost per unit of storage reservoir that is unsuited for extensive recreational development; this site was investigated as a possible low flow augmentation site for white water canoeing; an alternate site would be 26-3A.
26-2B			X	X			Low cost per unit storage site with possibilities of being used for low flow augmentation for white water canoeing; this site is not suited for extensive recreational development.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System			PFW Plan	CC Plan	Reasons for Selection or Rejection
		EE	RD	EQ			
UPSTREAM RESERVOIR SITES							
26-3A			X	X			A low cost per unit of storage site which is very poorly suited topography wise for extensive recreational development; this site could be used for flow augmentation for white water canoeing.
26-4							A fairly large and expensive upstream reservoir located upstream from George B. Stevenson Dam.
26-5							A smaller reservoir located upstream from its alternative 26-4; the site's location upstream from Stevenson Dam reduces the beneficial value that it could serve.
27-1		X	X		X		A large, fairly expensive site unsuitable for multiple purpose development; site could serve as a single purpose flood control site to help protect Emporium; the steep topography does not lend this site for extensive recreation development.
27-2							A small, fairly expensive site located upstream from Sterling Run; this site offers limited flood control and recreation development opportunities; this is an upstream alternative to site 27-13.
27-3							An extremely expensive reservoir site which could be used for partial flood protection along Sinnemahoning and Portage Creeks; its alternatives are 27-7, 27-7A, 27-8 and 27-9.
27-4A							A steep-sided reservoir unsuitable for extensive multipurpose development.
27-5							A fairly large but expensive upstream site which would be an alternative to site 27-1 or 66.
27-5A							A smaller upstream alternative site to 27-5.
27-6							A fairly large alternative site which could be developed for partial flood control at Emporium; site may be too expensive for economic justification using conventional evaluation methods.
27-6A							A smaller upstream alternative to 27-6 which would be somewhat more expensive.
27-7							A steep-sloped, expensive site which could provide partial flood control on Sinnemahoning Creek and Portage Creek.
27-7A							Another steep-sloped, expensive site which could provide partial flood control along Sinnemahoning Creek and Portage Creek.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
27-8							Another steep-sloped, expensive site which could provide partial flood control along Sinnemahoning and Portage Creeks.
27-9							
27-10							A very expensive small flood control site on Driftwood Branch offering only a partial flood reduction potential at Emporium.
27-11							An upstream flood control site offering partial flood control to Rathbun, Beachwood and Howard; its alternative would be 27-12.
27-12							An upstream flood control site on West Creek which, along with its alternative 27-11, may be economically unjustified.
27-13							A site located upstream from Sterling Run which could provide flood protection; however, this site may not be economically justified.
27-14							An alternative to site 66 which is both smaller and offers less flood control.
28-2A			X	X	X	X	This site, along with 28-3 and 28-4, could give partial flood protection to Penfield, Tyler, Weedville, and to the railroad which follows the valley; this aesthetically pleasing site could be built to assist the area's regional growth while providing additional recreation and fishing opportunities. 2000
28-3		X	X		X	X	This site, along with 28-2A and 28-4, could give partial flood protection to Penfield, Tyler, Weedville, and to the railroad which follows the valley; this aesthetically pleasing site could be built to assist the area's regional growth while providing additional fishing and recreational opportunities. 2020
28-4		X	X	X	X	X	This site, along with 28-2A and 28-3, could give partial flood protection to Penfield, Tyler, Weedville, and to the railroad which follows the valley; this aesthetically pleasing site could be built to assist the area's regional growth while providing additional fishing and recreational opportunities. 2020

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System			PFW Plan	CC Plan	Reasons for Selection or Rejection
		EE	RD	EQ			
UPSTREAM RESERVOIR SITES							
28-6A				X	X	X	A relatively efficient water storage reservoir located such that a permanent lake would have two main branches and several small fingers that blend pleasingly into the surrounding wooded countryside; Dents Run is currently polluted from mine acid drainage, but is expected to be cleaned up before this site is constructed for recreational use. 2000
28-7				X			This site was considered because of its aesthetically pleasing layout in respect to the surrounding terrain; the reservoir could be developed for fishing and recreation.
28-7B							This site is located downstream from its alternate 28-7; also, a site here would be more expensive on a basis of unit water storage.
025-1	X		X	X	X	X	A small site especially well suited for fishing and recreational development; a reservoir at this site would encourage an unpopulated area to grow when Interstate Route 80 is completed. 1980
025-2	X		X		X	X	A small site especially well suited for fishing and recreation development; a reservoir development; a reservoir at this site would encourage an unpopulated area to grow when Interstate Route 80 is completed. 1980
025-3		X					A small upstream reservoir not investigated for fishing potential; this site is an alternate to 025-2.
025-4		X					Interstate Route 80 relocation would make this site impractical.
025-5B							This relatively large site is not favorably suited for extensive recreational use could be developed for fishing.
025-6							An upstream site which would be difficult to build access roads to.
025-7							This upstream reservoir which has unfavorable topography for recreational development.
025-8							A small, expensive upstream site which may satisfy some water resource needs.
026-1							This small upstream site is located halfway between Bush and Stevenson Dams, thus minimizing the beneficial value.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
SUB-BASIN V							
14-1				X			A small upstream reservoir which could be utilized for recreation in the Lewisburg and Mifflinburg area; the site, which is located along Pennsylvania Route 45, would be aesthetically pleasing; however, desire to preserve as a trout fishing stream eliminates the site from the plan.
15-1			X				A fairly large and efficient upstream reservoir well suited for fishing and recreational development; this site located adjacent to Nittany Mountains in Little Sugar Valley would benefit the villages of Nittany and Lamar through regional development; this site was eliminated from the plan because of its proximity to Blanchard Dam on Bald Eagle Creek.
16-1		X			X	X	A small upstream reservoir that is well suited for recreational and fishing development; this site, along with 16-2, would be located along Pennsylvania Route 144 midway between Renovo and Moshannon; a recreation development at this location would help to satisfy the basin's needs. 1980.
16-2		X			X	X	Another small upstream site well suited for recreational and fishing development; this site, along with site 16-1, could be developed as a recreational complex to help satisfy the basin's needs. 2000
16-4A							An expensive upstream reservoir which is not suitable for recreational use because of the steep topography.
17-1	X						A large upstream reservoir located near Blanchard Dam which nullified this site's need.
17-2							An expensive site investigated along with 17-3 and 17-4 for possible flood control along Bald Eagle Creek.
17-3							Another expensive site investigated along with sites 17-2 and 17-4 for possible flood control along Bald Eagle Creek.
17-4							An expensive upstream reservoir analyzed with 17-2 and 17-3 for flood control potential along Bald Eagle Creek.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
21-1			X				A small but relatively efficient upstream reservoir suitable for fishing and recreation which would greatly assist Opp and Moreland areas through regional development; the nearness of this site to 21-8 keeps it out of the plan.
21-2			X				A very small upstream reservoir suited for fishing but not recreational development because of the steep topograph and extensive agricultural use of the watershed.
21-3	X	X				X	An upstream reservoir well suited for fishing use; a site here would complement fishing at nearby Beaver Lake. 2020
21-4		X		X			A small upstream reservoir not well suited for recreation use because of the steep topography; fishing could be developed on this reservoir; a site here would be an alternative water supply for Picture Rocks, Hughesville and Muncy.
21-5	X	X	X		X	X	A small upstream reservoir favorably located near populated centers of Williamsport, Montoursville, and Muncy; this site, favorable for both fishing and recreational development, would satisfy part of the area's needs. 1980
21-8	X	X	X	X	X	X	A large upstream reservoir especially well suited for fishing and recreational development; the site's location is ideal to satisfy needs of the populated central Susquehanna River Basin; such a reservoir with two major branches and several fingers would be both efficient and aestehtically pleasing in meeting the needs; the Muncy-Hughesville areas would benefit by regional expansion. 1980
22-1	X	X		X	X	X	A large upstream reservoir well suited for extensive recreational and fishing development; although this potential site is in Sub-basin V, it is but 30 miles from the populous Wyoming Valley; this site would greatly enhance the economic growth of Mildred and Lopez areas; the resulting reservoir area would have many fingers and branches, thus making it aesthetically pleasing. 1980
22-4	X	X				X	An extremely efficient water storage reservoir suited for both fishing and recreational uses; the site islocated 10 miles north of Williamsport and would help satisfy most of the needs. 1980

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
22-5	X	X				X	An efficient but small upstream reservoir site well suited for fishing use; a warm water fishery developed here would complement the excellent trout fishing on Loyalsock Creek and its tributaries. 2020
22-6	X	X	X	X	X	X	A small upstream reservoir investigated as a part of potential P.L. 566 watershed on Little Loyalsock Creek; this site would offer partial flood protection for Dushore and recreational use; water supply at Dushore may be an alternative use of the site. 1980
22-8		X	X			X	A small but efficient upstream reservoir site well suited for both fishing and recreational development; this site along with sites 22-4 and 22-5 would help satisfy Williamsport's future needs. 2020
23-1							A small but expensive upstream reservoir investigated for possible flood protection along Mill Creek; a site here could be developed for fishing use.
23-2							A small and expensive upstream reservoir site considered for possible flood control along Lycoming Creek.
23-8							Another expensive upstream site considered along with 23-2 for possible flood control on Lycoming Creek.
24-1	X		X		X	X	An expensive upstream reservoir site investigated along with 24-3 and 24-4 for possible flood protection at Galeton; this site could be developed for recreational and fishing use as well as low flow augmentation of Pine Creek upstream from the canyon area. 2020
24-3	X		X		X	X	This site, along with sites 24-1 and 24-4, was considered for possible flood control at Galeton; the reservoir could also be used for both recreational and fishing along with low flow augmentation of Pine Creek above the canyon. 2020
24-4							This site could help in possible flood protection at Galeton; because of site conditions, the reservoir area is not suited for either fishing or recreational development.
24-5		X	X	X	X	X	This upstream reservoir is the most efficient water storage site in Sub-basin V; it can be developed for extensive recreational and fishing use; this location in the Northern Tier counties fits into the recreation corridor planned. 1980

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
PA-603		X		X	X	X	1980
PA-604		X		X	X	X	1980
020-1							A small upstream site that was investigated along with 020-2, 020-3, and 020-4 for possible flood protection on Chilisquaque Creek in the vicinity of Washingtonville.
020-2	X	X	X		X	X	A small upstream site that was investigated for possible flood control along Chillisquaque Creek; sites 020-1, 020-3, and 020-4 would be the principal alternatives; this site lends itself ideally to both fishing and recreational development. 2000
020-3			X				A small upstream site that was investigated along with 020-1, 020-2, and 020-4 for possible flood protection on Chillisquaque in the vicinity of Washingtonville.
020-4							A small upstream site that was investigated along with 020-1, 020-2, and 020-3 for possible flood protection on Chillisquaque Creek near Washingtonville.
020-5A							Another small and efficient upstream reservoir site considered for possible flood control along Muddy Creek; this site would be suitable for extensive fishing development.
020-7				X			A small efficient upstream site that would be utilized for partial flood protection on Delaware Creek and fishing; because of the reservoir configuration it would have an aesthetically pleasing contrast with the landscape; the nearness of the site to the West Branch of the Susquehanna River keeps the site out of the prospectus.
020-8			X	X	X	X	A very efficient reservoir well suited for recreation and fishing use; the site is located between Lewisburg and Sunbury and would help satisfy their needs; also, the site would be visible from U.S. Route 15 and thus add a pleasant landscape contrast for people using that highway. 1980
021-1							A small, efficient upstream reservoir located on a high value trout fishery.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
021-3				X			A medium-sized upstream reservoir considered for possible flood protection along White Deer Creek; however, desire to keep the stream from trout fishing prevents this site from being a part of the prospectus.
022-1			X		X	X	A small headwater reservoir site well suited for recreation and fishing use; the site will also provide partial flood protection for Cogan House and other areas along the headwaters of Larrys Creek. 1980
022-3							A larger upstream reservoir investigated for possible flood control along lower reaches of Larrys Creek; steep topography around the site makes this site unsuitable for recreational use.
023-1		X					A very efficient upstream reservoir which could be developed for fishing and recreational uses; however, difficult access keeps this site out of the prospectus.
023-2	X						A small upstream reservoir suitable for recreation and fishing development; this site's proximity to Kettle Creek Dam makes its need negligible.
023-4							
023-5							
024-1							A small reservoir site investigated for its potential to provide recreational use; alternatives 16-1 and 16-2 are somewhat more efficient in doing this.
024-2							Another small headwater reservoir site considered for recreational development; however, alternative sites 16-1 and 16-2 are better suited for this.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
SUB-BASIN VI							
7-2A							A fairly large upstream reservoir with steep slopes that limit the recreation development potential; the site was not investigated for inclusion of fishing as a purpose.
7-4A			X		X		An upstream site well suited for fishing use, but limited in its recreation potential because of the steep slopes; a site at this location would help Blairs Mills and East Waterford areas in regional growth.
7-5A							An upstream site with potential for recreational development; this site is an alternate to 7-4A.
7-6A							A fairly small dam near the old Horse Valley CCC Camp that may not be well suited for recreation development because of the steep slopes.
7-7A							A fairly small and inefficient upstream reservoir site which may be used as an alternate for 7-5A.
7-8							A fairly small reservoir which would involve considerable amount of road relocations if it were developed.
7-9							A small upstream reservoir which would be a somewhat more expensive alternative to 7-10; the site was not investigated for its fishing and recreation potential.
7-10		X	X	X	X	X	A very efficient upstream site well suited for fishing and recreational development; a site here would be aesthetically pleasing and could help McCullochs Mills area grow through regional development. 2000
7-12							This fairly expensive upstream site has steep side slopes that limit it for recreational use.
7-14							A long and narrow upstream site not well suited for recreation because of the steep side slopes.
8-1							A small site which would inundate Wishort Swamp and result in considerable wild life mitigation of damages.
8-2							A larger site downstream from 8-1, but would be limited by steep slopes for recreation use.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
8-4				X	X	X	A fairly large and efficient site located near Burnt Cabins; this site could be developed so that travelers along the Pennsylvania Turnpike could see it; the site is suitable for fishing and recreation use along with stream augmentation for Aughwick Creek. 1980
8-7							A fairly large upstream reservoir site poorly located for easy access; the site could provide water supply for Shirleysburg.
8-8		X	X		X	X	A very efficient upstream reservoir located near the Pennsylvania Turnpike and is suited for extensive recreational and fishing development; a site here would help the Enid and New Grenada areas grow through regional development. 1980
8-9							A fairly small upstream reservoir site which would have steep side slopes that limit use of the site for recreation.
8-10							This is one of the most efficient upstream sites in the Juniata River Basin for water storage ability; however, this site is located where steep side slopes would limit the recreation development potential; the side could be used for flow augmentation along Aughwick Creek.
8-11		X		X			A site here would give the lowest cost per unit of water storage in the Juniata River Basin; however, this small upstream site could not be utilized effectively for recreation because of the steep side slopes; sites 8-9 and 8-10 are alternates to this location.
9-2				X	X	X	A large and efficient upstream reservoir suited for recreational development; the site is located on Great Trough Creek which is polluted by acid mine drainage thus making it poor for fishing use; the site's nearness to Raystown reservoir makes it undesirable for the immediate future; the site is a smaller alternative to 9-7 located on Trough Creek. 2020
9-4							Another efficient upstream reservoir site which will be partially inundated by Raystown Reservoir.
9-7							A large upstream reservoir well suited for extensive recreational use; its location near Raystown Reservoir will minimize the immediate need for this site.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
10-2			X		X		A potential upstream flood protection reservoir which, along with 10-3, would give partial flood control to Reynoldsville and along Dunning Creek.
10-3			X		X		A potential upstream flood protection reservoir which, along with 10-2, would give partial flood control to Reynoldsville and along Dunning Creek; these sites are not economically justified using current criteria.
10-6		X	X	X	X		An upstream reservoir suitable for recreational development and water storage for irrigation; the site was not selected because of its proximity to Shawnee State Park.
10-10		X		X	X	X	A fairly efficient upstream reservoir well suited for recreational and fishing development; a site at this location would be aesthetically pleasing contrast with the countryside. 2020
10-11					X	X	A large upstream reservoir adapted for recreational and fishing potential development; a site here would help Clearville, Mattie and Mench areas to satisfy recreation and fishing needs; the principal alternative to a site here is 10-13. 1980
10-13		X	X	X			This large efficient reservoir would be suited for extensive recreational development and water supply for Crystal Spring; a site here would assist Gapsville and Crystal Spring area in regional economic growth; such a site would be aesthetically pleasing and located near Interstate Route 70.
11-3		X	X	X			A very large upstream site located on a high value trout fishing stream; the site was screened out of the planning process because a small State Park is being built at this location; the State Park will satisfy part of the recreation needs of the Altoona area.
11-5A							An expensive upstream site investigated for possible water supply storage at Newry; the alternate cost of ground water development would be less expensive.
11-6							An expensive upstream site investigated as potential water supply for Claysburg; ground water use would be the lowest cost source.
11-9							An expensive upstream site investigated as a potential water supply source for East Freedom.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System			PFW Plan	CC Plan	Reasons for Selection or Rejection
		EE	RD	EQ			
UPSTREAM RESERVOIR SITES							
11-11A							A small, expensive upstream reservoir investigated as a potential flood control measure for Lakemont.
11-14							A small expensive upstream reservoir investigated as a potential flood protection measure for Canaan, Beryl, and Stiffler.
11-16A							A small, expensive upstream reservoir investigated for its potential to reduce flooding at Duncansville.
11-17							Another small and expensive site looked at for the possibility of flood protection at Duncansville.
12-6	X						This small, expensive upstream reservoir was considered, along with 12-11 and 12-12, for partial flood protection on South Bald Eagle Creek.
12-7							A small, expensive upstream site investigated for its potential to supply water to Grazierville and Tyrone.
12-8			X	X			A potential upstream reservoir which could be developed for water supply at Bellwood and Tyrone; the principal alternatives would be Site 131 and ground water; the site's steep topography makes it unfavorable for extensive recreational development.
12-11	X						A small, expensive upstream dam considered along with 12-6 and 12-12 for partial flood protection at Tyrone.
12-12	X						This site is an alternative location for Site 129; the site was investigated for water supply at Tyrone along with 12-6 and 12-11 for partial flood protection along South Bald Eagle Creek.
013-1A							A large, efficient upstream site which is suitable for extensive recreational development; a site here would partially protect flooding along Little Juniata Creek at Duncannon; this site is a downstream alternative to 013-5; the immediate need for a recreation lake here is minimal as a State Park is being constructed on Buffalo Creek.
013-2			X				A large, efficient upstream site well suited for extensive recreational development; the site was screened out of the project formulation because Raccoon Creek is a high value trout fishery.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
013-4							A small-sized upstream site not suited for recreational development because of the steep slopes.
015-2							A small inefficient water storage site with steep slopes making it unsuitable for extensive recreation use.
015-6	X	X		X	X	X	A very large upstream reservoir especially well suited for extensive fishing and recreational use; this site would satisfy many of the needs in the sub-basin; economically efficient; the site is located where a lake with two main branches and several smaller fingers could be created; desire by the State to keep projects which involve many acres of land being taken out of tax rolls kept this site from being a part of the prospectus. 2020
015-9							A small and inefficient upstream site investigated for its potential flood protection along Lost Creek.
015-10							A very small reservoir site which could be developed into a community park near Oakland Mills.
015-11							A larger downstream alternative to 015-9; a site at this location could be developed for extensive recreational use; such a site would satisfy needs in the Mifflin and Mifflintown area.
015-14				X			A smaller and very efficient upstream reservoir which could be made into a recreation park near Mexico; this site was screened out of project formulation because of the nearness to the Juniata River.
016-1							A small upstream alternative to 016-2; this site could be built for limited recreation use in the McClure area.
016-2							A larger upstream site capable of being developed for recreation use; however, this site is located near 016-3, a much more efficient site.
016-3		X	X		X	X	A medium-sized upstream reservoir well suited for extensive recreational and fishing use; also, this site can be developed for water supply at Paintersville. 1980

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
016-8							This medium-sized and efficient upstream reservoir has steep slopes that limit the recreational use potential. The site is located midway between Mapleton and Huntingdon.
016-9							A very small upstream alternative for site 016-16.
016-10							A very small and inefficient reservoir located upstream from Granville.
016-14							A small, expensive upstream site with potential of being used for water supply development.
016-15							A smaller and more expensive alternative to site 016-3.
016-16							A small but efficient upstream reservoir well suited for recreational use. However, its location close to the Juniata River midway between Lewistown and Huntingdon tends to minimize its value.
017-4B							A medium-sized and average efficiency upstream reservoir screened out of project formulation because Standing Stone Creek is a high value trout fishery.
017-7							A very small but fairly efficient upstream site screened out because of possible wildlife mitigation of damages if the swamp area were inundated.
017-8							A very small and expensive reservoir site located on Henry Run, a tributary of Shaver Creek.
017-11							A small upstream reservoir which would partially inundate a swamp.
017-13							A small and very expensive reservoir site located in steep terrain thus making it undesirable for recreation development.
017-17							An upstream reservoir which has steep slopes thus making the stie undesirable for extensive recreational development.
017-19							A small upstream reservoir located near the Juniata River which would make site for recreation unneeded at this location.
018-1							A small and expensive headwater site which would require road and building relocations.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System			PFW Plan	CC Plan	Reasons for Selection or Rejection
		EE	RD	EQ			
UPSTREAM RESERVOIR SITES							
018-2							A somewhat larger reservoir than 018-1, but site development would be limited by the steep topography.
018-4							A small upstream reservoir which would require major relocation of Pa. Route 747. This site could be used as an alternate water supply source for Mapleton.
018-5							A small site located at the mouth of Smith Run. The steep topography and nearness to the Juniata River limit this site for recreation development potential.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
SUB-BASIN VII							
5-11							This site, along with all other upstream reservoirs on Conodoguinet Creek, was investigated as potential flood control and water supply for irrigation sites.
5-13		X	X				This site, along with all other sites located on Conodoguinet Creek, was considered for possible flood control and irrigation water supply reservoirs.
5-15		X	X				This site, along with all other sites located on Conodguinet Creek, was considered for possible flood control and irrigation water supply reservoirs.
5-18	X	X	X	X	X	X	This large but fairly expensive upstream site was investigated for potential irrigation supply and flood control; this site is also well suited for extensive recreational and fishing development; a site at this location would benefit the Newville area through regional growth and benefit Carlisle by offering partial stream flow control. 2000
5-21	X	X	X	X			This medium-sized upstream reservoir was investigated for its potential flood control along Conodoguinet Creek, recreation, fishing and irrigation water storage; a lake at this location would be visible from the Pennsylvania Turnpike; Shady Grove reservoir would make construction of this site unneeded at the time being.
5-23	X	X	X	X			Another headwater reservoir site on Conodoguinet Creek investigated for flood control, recreation, fishing and irrigation water storage; a site at Shady Grove would minimize immediate need for this site.
5-29		X	X	X			Another headwater reservoir site along Conodoguinet Creek studied for irrigation storage, recreational use, fishing and potential flood reduction; use of alternative site at Shady Grove would make this unneeded in the immediate future.
5-35		X		X			An expensive headwater site investigated as a possible alternative for Shippensburg water supply.
5-36		X		X			Another expensive headwater reservoir looked into for possible use as an alternative water supply source for Shippensburg.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
6-1							A fairly efficient upstream reservoir investigated, along with all other headwater sites on Sherman Creek, for its flood protection potential; since this site is located on Bixler Run, a high value fishery, further consideration of this site was not made; possible irrigation water storage could be added to this site.
6-2							A headwater reservoir site studied for its potential in reducing flood levels along Sherman Creek.
6-4							Another headwater reservoir site studied, along with all other upstream sites along Sherman Creek, for its potential flood reduction.
6-5							A small headwater site investigated for its potential in reducing flood levels along Sherman Creek.
6-6							A small and expensive site along Sherman Creek studied for its potential in reducing flooding; steep topography on this site makes this site unsuited for recreational use.
6-7							Another small and expensive headwater site studied for its potential in reducing flooding along Sherman Creek.
6-9							A small headwater site investigated for its potential in reducing the flood stage on Sherman Creek; steep topography around the reservoir area limits recreational use.
6-11							Another small upstream reservoir studied for its potential of reducing flooding along Sherman Creek.
6-13		X	X				Another headwater reservoir site studied for possible flood reduction along Sherman Creek; a site at this location could be used for recreation and irrigation water storage; desire to preserve stream from fishing keeps the site out of the prospectus.
6-14			X				Another headwater reservoir site investigated for partial flood reduction on Sherman Creek; irrigation water storage and recreational uses could be included as a site purpose.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
13-1							A small and expensive headwater reservoir studied for possible recreation and irrigation water storage uses.
13-2		X	X	X	X	X	A relatively low cost water storage potential site considered primarily to be used for irrigation. Farms in the fertile valleys along Mud and Penn Creeks just downstream from the reservoir site would use the water for irrigation. Ground water development would be an alternative source of water. 2020
13-3							A small headwater site investigated for possible recreational use. Unfavorable topography and access would make this site undesirable.
13-4							Another tiny headwater reservoir site investigated for potential recreational development. The nearness of this site to PA-636 and PA-637, two P.L. 566 watershed multiple-purpose reservoir sites for flood control and recreation located on adjacent Middle Creek, minimizes the need for 13-4.
13-5		X	X	X	X	X	A relatively efficient and moderate-sized upstream reservoir site suitable for extensive recreational development and flood protection at Woodward and other areas along Pine Creek. A site here would be especially helpful in aiding the Woodward area's growth. This site is needed to help satisfy the great recreation needs of the Central basin. 2020
32-1		X	X				A relatively small but very efficient storage reservoir which could provide water supply for Uniontown. The site has potential for recreational development, except that its location near the Susquehanna River minimizes this need.
32-2		X	X				A large relatively efficient reservoir well suited for recreational development. Desire to keep Deep Creek a high value natural fishery keeps this site out of the prospectus.
32-4							Another relatively efficient upstream reservoir which could be utilized for recreation and irrigation water storage. Poor water quality minimizes value of site for public use.
32-5					X	X	A small but very efficient headwater reservoir site especially well suited for fishing and recreational use. Since Deep Creek is somewhat polluted at this point, construction of 32-5 should be delayed until the quality of water has been improved. 2000

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
32-7							A very small headwater site with possibilities of being utilized for recreation and irrigation water storage. However, an alternative, site 32-9, is located just downstream.
32-8				X			A relatively efficient headwater reservoir studied for its potential recreational use. An alternative, site 32-9, is better suited and located just downstream.
32-9		X	X	X	X	X	A fairly large upstream reservoir site well suited for extensive recreational use. Water at this location is polluted and it would be desirable to delay construction of 32-9 until such a time that the water quality is improved. Inclusion of irrigation water storage would be an alternative use of this site. 2020
33-3					X	X	A small headwater reservoir site located just downstream from Elysburg. This site is very well suited for fishing and recreational use. A site at this location would help satisfy recreational needs of the populous Central basin area. 2000
33-4			X				A fairly large reservoir studied as a possible mulitpurpose reservoir for flood control on Little Shamokin Creek, water supply for Sunbury, and recreation use for the Sunbury-Shamokin area. The site's location near the Susquehanna River minimizes 33-4's need.
33-6							A small headwater site located just upstream from Stonington. The site 33-6 could be used for recreational purposes or water supply development.
04-1							An efficient upstream site investigated as a potential water supply source for Millersburg.
04-2		X	X		X	X	A small headwater site well suited for fishing use. Recreational development could be incorporated to a limited extent in 04-2. A site here would be beneficial to Gratz. 2000
04-3	X				X	X	This small expensive upstream site was studied primarily as a water supply source for the Lykens area and a potential fishing and recreational area. The steep topography will limit recreational use at the site. 2020

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
04-5							A fairly small upstream site investigated as an alternative water supply source for the communities of Tower City, Williamstown, Wiconisco and Lykens.
04-7	X	X	X	X	X		A large upstream reservoir capable of supplying much of the unsatisfied water-oriented recreational and fishing needs of the Harrisburg area. This reservoir would have potential of meeting future water supply needs. Desire to preserve Powell Valley in its present state of development keeps this dam out of the prospectus.
04-8	X		X	X	X	X	Another large upstream reservoir site capable of satisfying much of the Harrisburg area recreational and fishing needs. The site location near the Susquehanna River makes it more desirable to delay construction until the future. 2020
04-9	X	X	X				This headwater reservoir is the most efficient water storage site in Subbasin VII. The reservoir site is located on State Game Lands and would require considerable reassessment of wildlife management in the area if it were to be built. The reservoir has potential to be used for an alternative water supply source and recreation.
05-3		X	X	X			A small headwater reservoir investigated for partial flood protection at Gordon and other areas along Mahanoy Creek. The site is not suited for either recreational use or water supply since the stream is polluted.
05-4							A small and expensive upstream reservoir studied as an alternative water supply source for the Ashland-Frackville area.
05-5							A small upstream reservoir site considered for possible recreational use. This site would be an alternative for 32-5.
05-6	X						A larger reservoir site investigated for flood control along the lower reaches of Mahanoy Creek. Reservoir would be limited for other uses because of the poor water quality.
013-5		X	X	X	X	X	An efficient and small upstream site capable of partial flood reduction along Little Juniata Creek. A site here is well suited for recreational and fishing development to satisfy New Bloomfield's needs. This watershed with site 013-5 would qualify for Federal assistance through P.L. 566.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
014-1A		X	X	X	X	X	A large efficient upstream reservoir especially well suited for extensive recreational and fishing development. The reservoir is favorably located about midway between Harrisburg and Sunbury, Pennsylvania. Besides being economically efficient and aesthetically pleasing, the reservoir would aid the Liverpool area through regional development. 1980
014-2							A very expensive upstream site investigated for possible recreational use. The site's location near the Susquehanna River minimizes its need.
014-3							Another fairly large reservoir investigated for its potential.
014-4			X				A small headwater reservoir site capable of providing recreational and fishing use. The site was selected in the regional development plan as an alternative to assist the Montgomery Ferry and Liverpool area's economic growth.
014-6							Another very small headwater site studied for recreational use. Lack of suitable cover near reservoir limits use of the site.
014-7							An alternative site to 014-1A which is both smaller and more costly on a unit basis for providing recreational services.
014-8							A small but relatively efficient upstream site suited for recreational use and located about midway between Stradle and Port Trevorton, 014-1A a much larger alternative site, makes an upstream reservoir unnecessary here.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
1-1						X	A small headwater reservoir investigated for its fishing and recreation potential; this site, along with 1-6, was selected for the prospectus when 1-2 was dropped. 1980
1-2	X	X	X	X	X		A larger and very efficient headwater reservoir site investigated for possible recreation and fishing use; incompatibility with the existing Harford County Park System keeps this site out of the prospectus.
1-3							A very small upstream site located on relatively steep topography which makes it unsuited for recreation.
1-5A	X	X	X	X	X	X	An upstream reservoir site suited for both fishing and recreational use; the site's location near large population centers favors its early construction; the aesthetically beautiful reservoir would aid the northwest corner of Harford County and northeast corner of Baltimore County in regional growth. 1980
1-6	X		X			X	A relatively efficient upstream reservoir suited for recreational and fishing use; a reservoir at this location would be used in lieu of 1-2; its location near Baltimore would assure maximum use of site. 1980
2-1							This relatively small site would be located just upstream from a new water supply reservoir used to serve York, Pennsylvania.
3-1							A small headwater dam investigated as an alternative water supply source for York Springs; also, the site would be suitable for fishing use.
3-2		X	X				A relatively small headwater reservoir investigated as an alternative water supply source for Franklintown; the reservoir would be too shallow for extensive fishing use.
3-3		X	X			X	A relatively efficient upstream reservoir well suited for fishing development; the site was also investigated for an alternative water supply source at Shiloh; a site here would benefit Spring Grove through regional growth. 2020
3-4							A relatively efficient upstream site investigated for its recreation use potential; Pinchot Lake located on a nearby State Park minimizes the need for this site.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
3-5		X	X	X			A fairly large site suited for recreation, fishing and irrigation water storage; alternative site 3-10A which is much larger would be more efficient for future development; the site could greatly benefit the Gettysburg, Hanover and York Springs area.
3-6		X	X				A small upstream site suited for fishing use; this site, along with 3-2, 3-5 and 3-7, could be developed to add significant warm water fisheries to lower basin.
3-7		X	X				Another small headwater site suitable to be used for fishing; the location near 3-10A minimizes immediate need for this site.
3-8A							A headwater reservoir investigated for possible irrigation water storage; there is a need for orchard irrigation water in this part of Adams and York Counties.
3-9							A small headwater reservoir studied as an alternative water supply source for Hanover and for orchard irrigation use.
3-10A	X	X	X	X	X	X	A very large and relatively efficient upstream reservoir site especially well suited for extensive recreational and fishing development; the site could be used in conjunction with pumping to higher elevation as an irrigation water source for orchards; the reservoir which would be aesthetically placed on landscape with several branches and fingers would benefit nearby Biglerville with regional growth possibilities; this reservoir would also be located about five miles north of Gettysburg, Pennsylvania. 2000
4-1							A small upstream reservoir site capable of being utilized for fishing; its alternative, site 4-2, is both larger and more efficient.
4-2		X	X	X	X	X	This very efficient upstream reservoir located between Dillsburg and Bowmansdale is suited for both recreation and fishing purposes; the reservoir would be easily accessible from route US 15 and offer many regional development opportunities. 1980
4-5							An upstream reservoir site investigated as an alternative water supply source for Pine Grove Furnace; the site could be developed to a limited extent for recreational use but steep topography would be an obstacle.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
4-6							A headwater alternative reservoir site for 4-5; this site could be utilized for water supply at Pine Grove Furnace but is not suited for recreational use.
4-7							A small headwater site studied for its possible irrigation water storage use.
4-11	X	X		X	X	X	A large and efficient upstream reservoir site suited for extensive recreational and fishing development; this reservoir located midway between Pine Grove Furnace and Mt. Holly Springs would aid the area considerably through regional growth aspects; the site is located near enough to the populous Harrisburg area to significantly help in satisfying the water oriented recreation requirements. 1980
29-1	X						A headwater reservoir site investigated for flood control along Basin Run at Liberty Grove and Rowlandsville; the site would also be suitable for recreation and fishing use; however, local desire to preserve stream in its present state keeps this site out of the prospectus.
29-3	X	X	X	X			An upstream reservoir site studied for possible use for fishing and recreation purposes; the site could be utilized also for irrigation water storage; desire to preserve the Valley Run in its present state of development keeps this site out of the prospectus.
29-4			X				Another headwater reservoir suitable for fishing, recreation and irrigation water storage purposes; the alternative site 29-5 is larger and more efficient.
29-5		X	X	X	X	X	An upstream reservoir site especially well suited for recreational and fishing development; the site's location near the headwaters of the Chesapeake Bay minimizes immediate need for the reservoir. 2020
30-2	X	X	X	X	X	X	A large upstream reservoir site capable of being developed for extensive recreational and fishing purposes; the site is located midway between Lancaster and Reading and would serve a large population base; the reservoir with its many branches and fingers would especially benefit Denver, Cocalico and Blairsport through regional growth; recreational development would need to be delayed until good shade trees could be established in the proposed camping and picnicking areas. 1980

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
30-7		X	X	X			A large but expensive upstream reservoir suited for development for fishing and recreational purposes; the site would be beneficial for Terre Hill through regional growth; this site could be utilized as an alternative water supply source for Lancaster, Brownstown and other communities along Muddy Creek and Conestoga Creek downstream from Muddy Creek junction; desire to preserve Lancaster County farm land keeps this site out of the prospectus.
30-8							This site is a smaller upstream alternative for 30-7 and is also located in Lancaster County.
30-9				X			This site is also an alternative reservoir site for 30-7 located on Black Creek adjacent to Muddy Creek; this reservoir site could be used for recreation, fishing, and as a water supply source for downstream communities.
30-12	X			X			A large but expensive upstream reservoir site located on Hammer Creek, a tributary of Cocalico Creek; the site could be utilized for extensive recreational use; Cornwall and Schaefferstown would benefit most if this site were constructed; desire to preserve this stream in its natural state for fishing use keeps the site out of the prospectus.
30-13A							A smaller alternative reservoir site to 30-12 located on Furnace Run, an adjacent stream; a dam here would benefit Clay and Hopeland through regional development.
30-14		X					A large upstream reservoir studied for its potential recreational use; however, this site would inundate valuable Lancaster County farm land and impede use of a high value trout fishery on Middle Creek.
31-1			X				A moderate-sized upstream reservoir investigated for recreational and fishing use; the reservoir would be located on highly populated eastern side of Harrisburg; present extensive development in the reservoir area keeps this site out of the prospectus.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	RD	EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
31-2A	X	X		X	X	X	A large upstream watershed reservoir near the mouth of Manada Creek suited for recreational and fishing development; the site would be located just north of Hershey and the reservoir pool would cross under present route US 22; this site would serve the populated Harrisburg area and benefit the Shellsville and Sand Beach area. 2020
31-4							A smaller and less efficient alternative to 31-2A located on Bow Creek.
31-5					X		A smaller but relatively efficient headwater site located near Indiantown Gap Military Reservation; Interstate Route 81 would be in the proposed reservoir area thus making it impractical to build the site.
31-9							An upstream reservoir site studied as a flood protection structure offering partial control at Ravine and Pine Grove.
31-10							Another upstream site studied as a partial flood protection structure for Pine Grove.
31-11			X				A relatively efficient upstream reservoir site which could be utilized for recreation and fishing; Pine Grove area would benefit heavily if this site were constructed for regional development purposes.
31-13							A much larger downstream alternative for 31-11; steep topography around the reservoir would limit the amount of recreational use that could be made at the site.
31-14		X	X	X	X	X	A medium-sized upstream reservoir well suited for recreation and fishing developments; a site here would especially benefit the Bethel, Schubert and Rehrersburg area in regional growth while serving the greater Lebanon area population. 2000
31-15							A somewhat larger alternative to 31-14; this site would inundate more valuable farm land and thus does not appear in the prospectus.
31-16				X			Another larger upstream watershed reservoir suited for both recreation and fishing use; this site is also an alternative for 31-14 and 31-15; desire to preserve the stream at its present state of development keeps this site out of the prospectus.

TABLE 13 contd
PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System EE	Response System RD	Response System EQ	PFW Plan	CC Plan	Reasons for Selection or Rejection
UPSTREAM RESERVOIR SITES							
01-1				X			A small headwater site studied as a partial flood control structure for the upper reaches of Paradise Creek in the vicinity of Buena Vista Lapps.
01-3							A small upstream reservoir investigated for possible recreation use; its location nearby the Muddy Run pumped storage and recreation project makes this site unneeded.
01-4	X			X	X	X	A larger upstream watershed with the structure and part of the reservoir located in Maryland and the remainder of the reservoir in Pennsylvania; the site is capable of being developed for recreation and fishing; a reservoir at this location would complement facilities located on the lake behind nearby Conowingo Dam. 1980
01-5							A small and less efficient upstream reservoir which is an alternative for 01-4; the upstream site would tend to compete with recreation facilities on Muddy Run Project.
02-1		X	X				A medium-sized headwater reservoir site suitable for both recreation and fishing purposes; also, the site was investigated to help reduce flooding along Toms Run; the site is not in the prospectus because of its remoteness from highly populated areas.
02-4							Another small headwater reservoir investigated as a potential recreation and fishing site; alternative sites on Deer Creek keep this site out of the prospectus.
02-7			X		X	X	Another upstream reservoir suitable for fishing and recreational purposes; the site is located near Hallan and Wrightsville and offers good access to the populated Lancaster and York areas; Margaretta Furnace and East Prospect area would benefit greatly if this reservoir were constructed for regional development. 1980
03-1	X	X	X	X	X	X	This site, along with sites 03-3, 03-8 and 03-9, was investigated as flood control structure to protect Manheim, Pennsylvania; in addition, this site could be utilized for recreational purposes; as a unit the four upstream reservoirs would qualify for a P. L. 566 watershed under the Watershed Protection and Flood Prevention Act. 1980

TABLE 13 contd

PLAN FORMULATION SUMMARY TABLE

Alternative	Base Plan	Response System			PFW Plan	CC Plan	Reasons for Selection or Rejection
		EE	RD	EQ			
UPSTREAM RESERVOIR SITES							
03-3	X		X		X	X	This site, along with sites 03-1, 03-8 and 03-9, was investigated as a flood control structure to protect Manheim, Pennsylvania. 1980
03-4							A very large reservoir located at the mouth of Conowingo Creek; the site could be utilized for recreation but would get serious competition from the nearby Susquehanna River.
03-8			X		X	X	This site, along with sites 03-1, 03-3 and 03-9, was investigated as a flood control structure to protect Manheim, Pennsylvania. 1980
03-9					X	X	This site, along with sites 03-1, 03-3 and 03-8, was investigated as a flood control structure to protect Manheim, Pennsylvania. 1980
03-11	X						A small headwater site studied to prevent flooding along reaches of Brubaker Run and to provide some recreation opportunities; this site does not appear in the prospectus because of local desire to protect Lancaster County farm land.

REPORT* OF THE PLAN FORMULATION WORKSHOP ON THE WORKSHOP PLAN - FIRST COORDINATING COMMITTEE CHANGES

A. GENERAL

The Workshop Plan for the Susquehanna River Basin Study includes the structural and management programs which the Plan Formulation Workshop recommends at this time to the Coordinating Committee to meet the water and related land resource needs of the Susquehanna River Basin.

A specific goal of the Workshop Plan is to meet the needs of the Basin through the year 2020. This can be best approached with a partnership of structural and management measures providing a mixture of conservation, development, preservation and restoration. Figures 20 and 21 on the following pages show the specific structural recommendations for 1980 and 2020, respectively, and do not reflect changes subsequent to November 1968.

Within this context, the Workshop Plan is responsive to three broad objectives: economic efficiency, regional development, and environmental quality. The Plan Formulation Workshop, with advice from the three States in the Susquehanna Basin, has considered the economic and social needs of the people in the Basin and has selected a local objective which appears to be the one most responsive to the needs of a specific geographic area.

For example, regional development was the objective at two specific locations in the Basin: (1) a higher level of flood protection than appears to be economically justified by "user benefits" was provided along the Chenango River below Norwich; and (2) more recreation sites in the West Branch area were included than appeared to be economically justified by "user benefits."

Other areas of the Basin, which are endowed with clean streams and heavily wooded areas, are more responsive to the environmental quality objective and are planned with a relatively high level of preservation. Examples are: (1) most of the Sinnemahoning Creek watershed and (2) most of the Pine Creek watershed.

* Text edited from actual Workshop Report of November 8, 1968 to the Susquehanna River Basin Study Coordinating Committee. Most of the Workshop Report inclosures have been omitted.

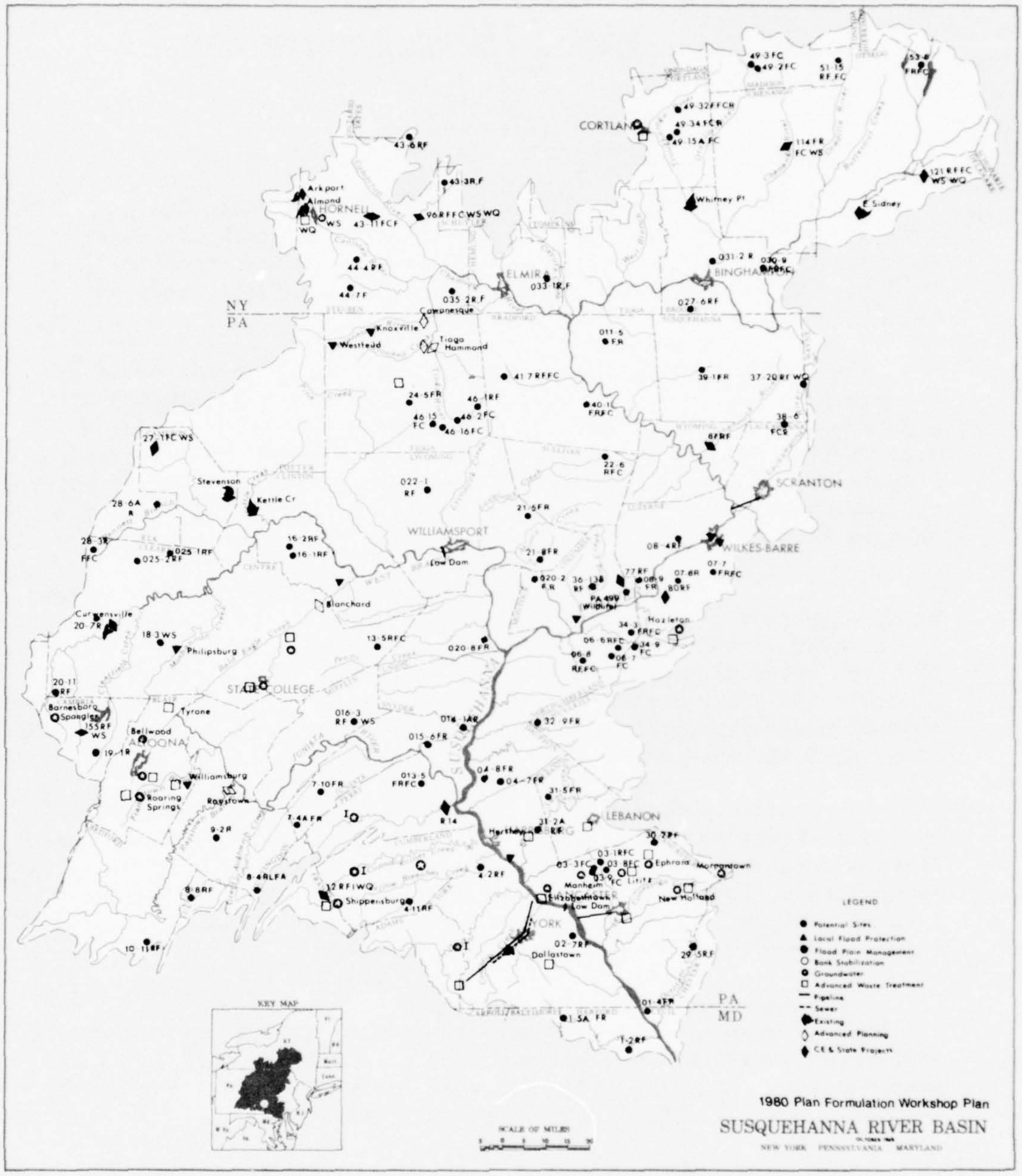
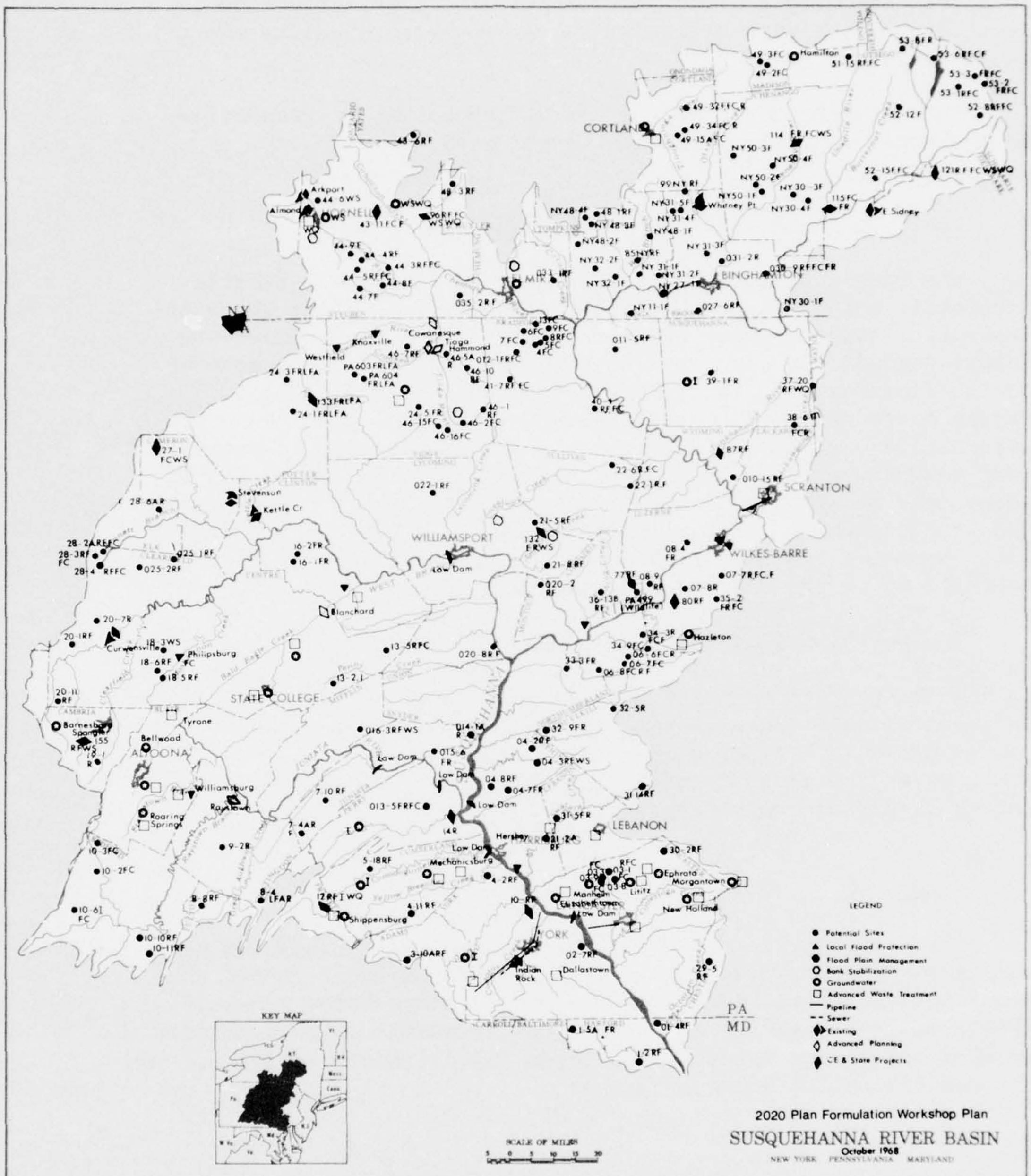

1980 Plan Formulation Workshop Plan
SUSQUEHANNA RIVER BASIN
NEW YORK PENNSYLVANIA MARYLAND
KEY MAP
SCALE OF MILES
LEGEND
Potential Sites
Local Flood Protection
Flood Plain Management
Bank Stabilization
Groundwater
Advanced Waste Treatment
Pipeline
Sewer
Existing
Advanced Planning
CE & State Projects
NY
PA
MD
CORTLAND
BINGHAMTON
ELMIRA
HORNELL
SCRANTON
WILKES-BARRE
WILLIAMSPORT
STATE COLLEGE
ALTOONA
LEBANON
YORK
Whitney Pt
E Sidney
Arkport
Almond
Cowanesque
Knoxville
Westfield
Tioga
Hammond
Stevenson
Kettle Cr
Curwensville
Philipsburg
Blanchard
Tyrone
Barnesboro
Spangler
Bellwood
Williamsburg
Raystown
Roaring Springs
Shippensburg
Hazleton
Ephrata
Morgantown
New Holland
Manheim
Lititz
Elizabethtown
Dallastown

Figure 20



CORTLAND
BINGHAMTON
SCRANTON
WILKES-BARRE
WILLIAMSPORT
STATE COLLEGE
ALTOONA
LEBANON
YORK
Hazleton
Hamilton
Shippensburg
Mechanicsburg
Hershey
Ephrata
Morgantown
New Holland
Dallastown
Indian Rock
Tyrone
Bellwood
Williamsburg
Roaring Springs
Curwensville
Philipsburg
Stevenson
Kettle Cr
Blanchard
Knoxville
Westfield
Cowanesque
Tioga
Hammond
Arkport
Almond
Whitney Pt
E Sidney
Low Dam
NY
PA
MD
KEY MAP
LEGEND
Potential Sites
Local Flood Protection
Flood Plain Management
Bank Stabilization
Groundwater
Advanced Waste Treatment
Pipeline
Sewer
Existing
Advanced Planning
CE & State Projects
SCALE OF MILES
2020 Plan Formulation Workshop Plan
SUSQUEHANNA RIVER BASIN
October 1968
NEW YORK PENNSYLVANIA MARYLAND

Figure 21

Some areas of the Basin, such as the Harrisburg vicinity, are relatively sound economically. Projects and programs are proposed generally to meet an economic efficiency objective in these areas, but with attention to environmental quality where conflicts occur.

This summary outlines how the Workshop Plan is responsive to the three objectives and the water-based needs.

B. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

The Plan Formulation Workshop considered all practicable alternatives for water supply at those locations where there is inadequate surface water under existing conditions to meet the future demand. Ground water development, pipelines, and augmentation from surface storage were included. At many locations, ground water appeared to be the least costly and most desirable alternative. At other locations where multiple purpose reservoirs were needed and ground water was not competitively available in acceptable quantity or quality, augmentation from surface storage has been proposed. Also, pipelines have been proposed to transfer water from the Susquehanna River to major needs centers where this appeared to be the least costly alternative.

The Workshop Plan includes measures to meet all of the anticipated water supply deficits throughout the Basin to the year 2020, so that lack of an adequate water supply would not be a constraint on regional development. The proposed water supply measures are compatible with all three objectives, but are generally most responsive to the economic efficiency objective, since the least costly dependable supply was selected.

C. AGRICULTURAL WATER SUPPLY

The Workshop Plan proposes measures to meet irrigation needs on streams where surface water deficits are expected to occur or where irrigation withdrawals would reduce flows below acceptable levels for water supply and water quality management. With some exceptions, ground water is the recommended (least costly) measure to meet irrigation needs.

D. GENERAL OUTDOOR RECREATION

The Recreational Subcommittee included in its recreation sub-study the demands for restricted and unrestricted boating and general water-oriented recreation. In most sub-basins, it was difficult to meet projected boating and water-oriented recreation day demands after 1980. Reservoir sites are available to meet these needs, but their inclusion would conflict with the objectives for the sub-basin where they are located. Several recreation projects in the Workshop plan are not economically "efficient" using conventional benefit analysis. Major recreational and upstream watershed projects were selected at locations with regional development potential where the reservoirs would be part of a recreation complex. It is anticipated that the total (including secondary) impact on the economy would more than justify the investment, under the assumption that there would be careful cooperative planning for service facilities, transportation, routes, etc., by the implementing agency and the locality involved.

Where development of a potential reservoir site would inundate a reach of stream worthy of preservation, the Workshop considered each conflict individually and its consensus is reflected in the Workshop Plan. There were differences of opinion among the Workshop participants as to which reservoir sites should be included in the plan and for what purposes. The Workshop believes that the Plan reflects a high level of stream management for recreation while satisfying a reasonable standard of boating needs. If a criterion of 2-1/2 acres of water surface per boat were used, most of the deficits would not appear, and some recreational boating facilities designated for 1980 could be deferred to late action.

A recreation measure equally as important as the proposed reservoir sites is the recommended system of stream categories -- wild, scenic, recreation and modified recreation. These would designate reaches where streamside management and recreational development would be necessary to achieve the recreational benefits.

E. FISH AND WILDLIFE

The Workshop Plan includes many fishing enhancement measures, both at and downstream from reservoir sites and along existing streams. The Basinwide needs would be met in 1980, although some of the demand in Sub-basins II and III would have to be met from surplus capability in other sub-basins. The 2020 fishing

needs are not met by the Workshop Plan for generally the same reasons as those for not meeting boating needs. The Workshop preferred to leave many streams in their present condition rather than develop them solely for fishing. In some locations, warm-water fishing could be developed with reservoir construction at the cost of losing some cold-water fishing. The Workshop preferred retaining the existing cold-water fishing except at a few sites close to large population centers to allow more persons to participate in fishing.

F. WATER QUALITY MANAGEMENT

A basic assumption agreed to by the Workshop was that all water service areas would provide secondary treatment except on certain acid streams in Pennsylvania. Where secondary treatment or its reasonable equivalent would not be adequate to meet the water quality standards of the several states (particularly for dissolved oxygen), advanced waste treatment and low flow augmentation were found to be the most feasible alternatives among those considered.

In some instances, low flow augmentation would not be a feasible solution due to inadequate yield from potential reservoir sites; in others, the yield would be adequate, but advanced waste treatment appeared to be a more economical or acceptable solution. Some potential sites for low flow augmentation would inundate scenic reaches of streams and conflict with the environmental quality objective. In those cases, other practicable means of achieving desired water quality were preferred.

G. COAL MINE DRAINAGE POLLUTION ABATEMENT

In the process of plan formulation, the selection of coal mine drainage pollution abatement measures for early action was based on:

1. A cost-effectiveness study in which individual watershed projects were compared on the basis of annual costs required to achieve measurable benefits.

2. Recommendations by Commonwealth of Pennsylvania agencies and local organizations on the regional development impact.

3. Investment constraints limiting early capital expenditures to approximately $100 million.

The selection of early action abatement recommendations included those projects which would enhance significant streams or stream reaches to provide the opportunity for more use of those streams at the end of the early action period. Coal mine drainage abatement projects which would incur proportionately high costs in relation to the identifiable tangible benefits to be achieved were deferred to the late action period. This was done partially to spread out investments over a longer period of time, and partially to allow for further data collection and development of abatement technology.

H. FLOOD DAMAGE REDUCTION

The Workshop Plan includes some structural protection to reduce average annual flood damages and suggests flood plain management measures to complement the structural protection. In a few locations where flood protection would enhance regional development, a higher level of protection has been proposed than is economically justified under strict economic efficiency criteria. Local flood protection projects are responsive to both the regional development and the environmental quality objectives.

In many headwater reaches, there are no suitable reservoir sites to afford flood protection. Some downstream reaches were not provided protection by use of major structural measures due to lack of economic justification or to preserve certain stream reaches in a free-flowing condition. Flood plain management measures will have to be implemented in both upstream and main river reaches to reduce flood damages effectively, and to complement structural measures.

I. LAND TREATMENT

The PFW Plan proposes a 20 percent acceleration of the present program of land treatment throughout the Basin, and complete treatment of all critical areas.

J. FIRST CHANGES BY THE COORDINATING COMMITTEE

The following changes to the Plan Formulation Workshop Plan were made by the Susquehanna Coordinating Committee at their December 1968 meeting. After the changes were incorporated, the Workshop Plan became the Susquehanna Prospectus of the Coordinating Committee, as noted in Chapter VIII of this Supplement. This was before the first of the local planning meetings held in early 1969 throughout the Basin, following which, another series of changes was made (See Attachment 5).

Sub-basin I

1. Add the following small reservoirs to assist in meeting deficit for fishing: 49-1, 49-22, 50-8, 028-1, 030-5 and 032-2.

2. Move the following small fishing sites from late action to early action (1980) to increase recreational attraction of area: NY11-1, NY27-1, NY30-1, NY30-3, NY31-2, NY31-3, NY31-4, NY32-1, NY48-1, NY48-3, NY48-4, NY50-1, NY50-3, and NY50-4 (also add recreation).

3. Delete category for Otselic River from the Chenango-Cortland County line to Whitney Point.

4. Designate Butternut Creek from source to Morris, N.Y. as "modified recreation" category.

Sub-basin II

1. Add upstream site 012-3 for flood control for late action.

Sub-basin III

1. Defer major recreation and fishing sites 77, 80 and 87 to late action as impracticably large for early action.

2. Add the following sites for fishing to reduce deficit during late action period: 010-9, 011-1, 38-10 and 39-10.

3. Designate the Susquehanna River from Sayre to the southern Wyoming County line as "recreation" category.

4. Delete ground water for irrigation in Wyalusing Creek watershed.

Sub-basin IV

1. Defer recreation site 155 to late action as impracticably large for early development.

Sub-basin V

1. Add site 22-4 for recreation and fishing (late action).

2. Add sites 21-3 and 22-5 for fishing (late action).

Sub-basin VI

1. Delete sites 10-2, 10-3 and 10-6 for flood control as not economically feasible based on reanalysis.

2. Designate Juniata River from Mt. Union to the mouth as "modified recreation" category.

3. Defer recreation site 9-2 to late action.

Sub-basin VII

1. Categorize Sherman Creek as "modified recreation" from source to Shermans Dale and defer major recreation site 14 to late action as too large for practicable early action development.

2. Categorize Conodoguinet Creek from site 12 to mouth as "modified recreation."

3. Delete ground water for irrigation in Sherman Creek watershed.

4. Delete recreation and fishing site 04-7 as conflicting with environmental quality objective.

5. Defer recreation and fishing sites 04-8 and 32-9 to late action.

6. Reduce storage in major multiple purpose site 12 (Shady Grove) to approximately 60,000 acre-feet to minimize impact on communities and farmlands in the area.

Sub-basin VIII

1. Add small fishing site 3-3 to late action.

2. Add ground water for irrigation in the Octoraro Creek watershed.

3. Designate entire reach of Muddy, Conestoga and Pequea Creeks as "modified recreation" category.

4. Defer recreation and fishing sites 29-5 and 31-2A to late action.

5. Delete small recreation and fishing site 31-5 due to conflict with new highway.

CHANGES IN THE SUSQUEHANNA PROSPECTUS DURING THE PUBLIC DISCUSSION PHASE

A. CHANGES FOLLOWING LOCAL PLANNING MEETINGS

Chapter X of this Supplement indicated that a number of changes were made in the Susquehanna Prospectus by the end of the series of local planning meetings held throughout the Basin in early 1969. Many of the changes listed in this Attachment were the direct or indirect result of the comments, ideas, and discussions generated by the participants in the local planning meetings. The remainder were the normal result of a continuing process of data improvement by the staff of the Coordinating Committee. Some of the data improvement, however, was based on information gained at the local planning meetings, making it impractical to specify the precise origin of many of the specific changes made. The items noted below represent the more important or locally significant additions and changes; a number of minor items are not shown.

Sub-basin I

1. Substitute site 49-28 for site 49-32 as an early action reservoir project for water quality management (Cortland, N.Y.), flood control, recreation and fishing. Data provided by the State of New York (see Appendix B) indicated site 49-28 to be a more efficient and preferable choice. Site 49-32 would be considered a primary alternative during the preauthorization stages.

2. Add site T-2 on Charlotte Creek for recreation to increase regional development impact of multiple purpose site 121 or its alternative; designate combination as Charlotte Creek complex. (Data provided by State of New York in Appendix B.)

3. Add site NY 52-1 for early action to improve fishing opportunity on eastern fringe of Basin (accessible to Schenectady and Albany).

4. Add channel improvement at Marathon, N. Y., as economically efficient and locally supported project to reduce flood damages.

5. Defer recreation and fishing site 48-1 to late action period.

6. Provide streambank stabilization along Wappasening Creek in Pennsylvania during early action period.

7. Change category of Butternut Creek from source to Morris, N. Y., to "recreation."

8. Change category of the Tioughnioga River from Cortland to Chenango Forks, and the Susquehanna River from Windsor to Cooperstown, to "modified recreation."

9. Remove stream category for Unadilla River.

10. Add a number of stream reaches to the "primary trout" category. (Included, for instance, were the Otselic River in Cortland County and Horse Brook in Delaware County.)

Sub-basin II

1. Add sites NY 33-3 (near Elmira, N.Y.) and NY 44-1 for early action to improve fishing opportunity.

2. Delete site 44-6 because of highway conflict.

3. Delete flood control sites 012-3, 012-4, 012-5, 012-6, 012-7, 012-9, and 012-13 (all in Bentley Creek watershed) as lacking economic justification following reanalysis.

4. Advance sites 012-1 and 012-8 to early action phase to increase flood control and recreation impact.

5. Add streambank stabilization on Bentley Creek and Cowanesque River in Pennsylvania for early action.

6. Add advanced waste treatment at Elmira for late action to complement water quality management capability.

Sub-basin III

1. Add low dam at Berwick for recreation (late action) to improve opportunity for boating.

2. Advance site 010-15 to early action to improve recreation and fishing opportunity near Scranton, Pa.

3. Add streambank stabilization on Fishing, Towanda, Wyalusing, and Wysox Creeks for early action.

4. Add streambank stabilization on East and South Branches of Tunkhannock Creek for early action.

5. Delete site 07-8 at local request and add site near Andy's Pond on Little Wapwallopen Creek for early action.

Sub-basin IV

1. Delete site 27-1.

2. Add ground water for water supply at Emporium for early action.

3. Add Lick Run, entire reach, as scenic stream.

Sub-basin V

1. Add Fishing Creek for its entire reach to Recreation category.

2. Defer advanced waste treatment at Lock Haven to late action.

3. Add coal mine drainage pollution abatement for Loyalsock Creek headwaters for early action at local request.

4. Add bank stabilization on Muncy and Little Muncy Creeks for early action.

5. Advance site 22-1 to early action at local request.

6. Add site 22-4 for early action to improve recreation and fishing opportunity.

7. Add site 22-8 for late action for recreation and fishing.

8. Advance sites PA 603 and PA 604 to early action.

Sub-basin VI

1. Defer recreation and fishing site 015-6 to late action as impracticably large for early action.

2. Delete low dams for recreation at Newport and Port Royal on the Juniata River in favor of more advantageous location.

3. Add low dams on the Juniata River for recreation at Lewistown (early action) and Thompsontown (late action) to reduce deficit in opportunity.

4. Add coal mine drainage pollution abatement for Frankstown Branch as early action project at local request.

5. Add Spruce Creek to "primary trout" category list at local request.

Sub-basin VII

1. Add low dam for recreation at Millersburg on the Susquehanna River as a late action project to reduce deficit in opportunity.

2. Defer low dam for recreation at Harrisburg on the Susquehanna River to the late action phase.

3. Add water supply as a purpose for storage at site 12, the Shady Grove multiple-purpose reservoir project.

4. Delete the stream category for Sherman Creek.

Sub-basin VIII

1. Add advanced waste treatment at York and Spring Grove for early action.

2. Add advanced waste treatment at Columbia and Lancaster (suburban) for late action.

3. Add site 1-6 in Maryland for early action for recreation; delete site 1-2.

B. CHANGES FOLLOWING PUBLIC FORUM MEETINGS

The following changes in the Susquehanna Prospectus were made by the Coordinating Committee during and after their July 1969 meeting. The Prospectus, as modified by these changes, became the Coordinating Committee Plan shown in the figures in Chapter X of this Supplement.

Sub-basin I

1. Defer the following fishing reservoirs to the late action plan to spread out the required investment: NY11-1, NY27-1, NY30-1, NY31-3, NY32-1, NY48-1, NY48-3, and NY50-1.

2. Delete site 031-2 and substitute site 030-9A for early action, following local response at Binghamton, N.Y., forum meeting.

3. Defer site NY85 to late action; designate West Branch of Owego Creek from Jenksville to the mouth as a Trout Primary category until NY85 is required in response to Binghamton Forum.

4. Advance fishing site 50-8 to early action plan.

Sub-basin II

1. Extend streambank stabilization along Cowanesque River to include selected areas from Westfield to Osceola, as requested at Towanda, Pennsylvania, Forum.

2. Add ground water for irrigation along the upper Cohocton River following the Elmira, N.Y., Forum.

3. Substitute Fivemile Creek (site 97) in early action Plan for site 43-11.

4. Restrict use of site 033-1 in early action Plan to wildlife and fishery enhancement.

5. Delete recreation and fishing site 43-3 from the Plan as unsuitable following reanalysis.

6. Substitute recreation and fishing site 035-1 for site 035-2 as more suitable.

7. Delete recreation site 43-6 from the Plan.

8. Delete ground water development at Bath for downstream water quality management; retain as an alternative.

9. Add fishing site 44-7 to early action Plan.

Sub-basin III

1. Delete the portion of Wyalusing Creek in Bradford County as "primary trout" category; add Middle Branch Wyalusing Creek in Susquehanna County as "primary trout" category, based on information from local citizen.

2. Extend "recreation" stream category and "warm-water fishery" category of Susquehanna River downstream to confluence of Lackawanna and Susquehanna Rivers, as requested at Wilkes-Barre, Pennsylvania, Forum meeting.

3. Add portions of the following streams to "primary trout" category in Luzerne County, as requested at Wilkes-Barre Forum: Arnold Creek, Kitchen Creek, and Hunlock Creek.

4. Include full local flood protection project at Bloomsburg, Pennsylvania, for regional expansion instead of limited protection for existing development.

5. Advance low dam for recreation on Susquehanna River near Berwick, Pennsylvania, to early action Plan to improve boating opportunity.

Sub-basin IV

1. Delete major recreation site 155 as impracticably expensive based on reanalysis of costs.

Sub-basin V

1. Add Babb Creek for early action abatement of coal mine drainage pollution at local request and as tributary to high value stream (Pine Creek).

2. Include local protection project at Lock Haven, Pennsylvania, to provide regional expansion benefits rather than protection only for existing development.

3. Delete recreation as purpose at site 24-1 in late action Plan; retain for fishing and recreation enhancement of Pine Creek by low flow augmentation (both quantity and quality management).

4. Include nutrient removal in advanced waste treatment recommendation for Bellefonte and State College, Pennsylvania, as requested at Lock Haven Forum.

5. Defer recreation and fishing site 020-2 to late action Plan to permit time for natural revegetation of prime recreational areas.

Sub-basin VI

1. Delete recreation and fishing site 7-4A; retain as late action alternative fishing site.

Sub-basin VII

1. Include nutrient removal in advanced waste treatment recommendation for towns discharging to Conodoguinet Creek, as requested at Harrisburg, Pennsylvania, Forum.

2. Delete site 14 from Plan as impracticable solely for recreational development.

Sub-basin VIII

1. Include nutrient removal in advanced waste treatment recommendation for communities discharging to Yellow Breeches Creek, as requested at Harrisburg Forum.

2. Add recreation site 1-1 in Maryland for early action.

SIMULATION ANALYSES

A. LOW FLOW CONDITIONS

General

The Susquehanna River provides about 85 percent of the fresh water flowing into the Chesapeake Bay above the mouth of the Potomac River. Fresh water inflow is the major factor controlling salinity distribution and the natural dynamics of water exchange in the Bay. Detailed simulation studies were necessary to determine to what extent the measures recommended in the Coordinating Committee Plan could compensate for anticipated losses in the low flow regimen of the Susquehanna River, due to the importance of this flow to the ecology of the upper Chesapeake Bay.

As noted in Chapter IX, four factors will result in future reductions in the quantity of water at the mouth of the Susquehanna River:

(1) Evaporation of water used for cooling purposes (during thermal electric power generation) to meet state stream quality standards for temperature.

(2) Increased municipal and industrial water supply use and related consumptive loss.

(3) Increased consumption of water for irrigation.

(4) Increased water supply diversion out of the Basin for the cities of Baltimore, Maryland, and Chester, Pennsylvania.

Objectives

There were five objectives for the simulation tests of the Susquehanna River Basin systems:

(1) Verify the efficacy of the Coordinating Committee Plan for meeting local upstream flow requirements within the Basin.

(2) Determine the separate effect of projected consumptive losses and diversions on the Basin flow regimen.

(3) Determine the cumulative projected effect of the Coordinating Committee Plan on the lower Susquehanna River.

(4) Identify any additional requirements and test potential solutions for mitigating the effects of a range of projected flow depletions.

(5) Establish a base for the measurement of potential benefits.

Program Capability

To carry out the simulation analyses, the major reservoirs in the Coordinating Committee Plan were included in the program capability*, as well as those existing and programmed Federal projects which would contain conservation storage as presently planned for operation. Table 14 below lists the latter projects by sub-basin; Figure 1 at the end of Chapter II shows their location.

TABLE 14
EXISTING AND PROGRAMMED RESERVOIRS
WITH CONSERVATION STORAGE **

Sub-basin	Reservoir	Storage Ac-Ft	Sub-basin	Reservoir	Storage Ac-Ft
I	Whitney Point	12,470	IV	Curwensville	9,370
II	Cowanesque	7,000	V	Foster J. Sayers	28,780
III	Tioga-Hammond	13,400	VI	Raystown	514,000

** Only those projects with at least 7,000 acre-feet of storage included.

The additional reservoir projects in the Coordinating Committee Plan are shown in Table 15 by approximate time indicated for their construction and by sub-basin. Figures 14, 17, and 18 in Chapter X show their locations.

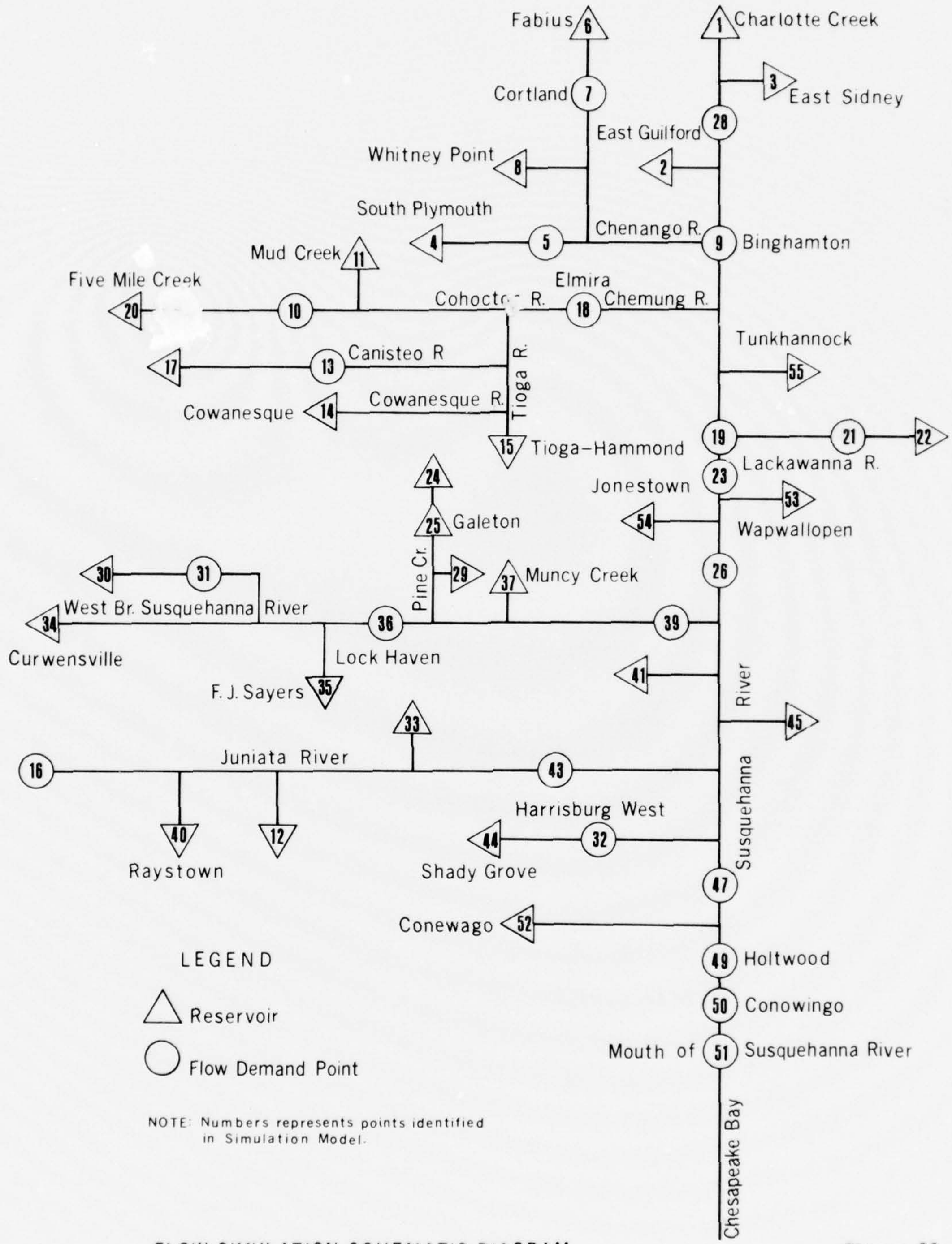
* HEC Program No. 23-X6-L253 (modified). See Chapter III.

TABLE 15
MAJOR RESERVOIRS IN COMPREHENSIVE PLAN
WITH CONSERVATION STORAGE

Plan Year	Sub-basin	Project Name	Inventory Number	Storage Ac-Ft
1980	I	Charlotte Creek	121	83,000*
1980	I	Fabius	49-28	21,000
1980	I	South Plymouth	114	21,000
1980	II	Fivemile Creek	97	33,000
1980	II	Mud Creek	96	28,000
1980	VII	Shady Grove	12	60,000
2000	I	East Guilford	115	105,000
2000	III	Wapwallopen	80	39,500
2000	V	Muncy Creek	132	62,000
2020	III	Jonestown	77	63,000
2020	III	Tunlhannock	87	62,000
2020	V	Galeton	133	10,400
2020	VIII	Conewago	10	60,000**

* exclusive of sub-impoundment T-2
** storage not to full capability

Figure 22 on the following page is a schematic diagram showing the relationship of the major projects affecting streamflow and the control or reference points used to measure simulated flows throughout the Basin. Table 16, following the figure, lists the more significant control points included in simulations, together with brief remarks on their purpose.



FLOW SIMULATION SCHEMATIC DIAGRAM

Figure 22

TABLE 16

MAJOR CONTROL POINTS USED IN SIMULATION STUDIES

Number	Significant Control Points	Sub-basin	Remarks
7	Tioughnioga River, at Cortland, N.Y.	I	Control and effects of Fabius project (49-28).
9	Susquehanna River, at Binghamton, N.Y.	I	Control and effects of Charlotte Creek project (121) and East Sidney; effects of Fabius project.
18	Chemung River, at Elmira, N.Y.	II	Control and effects of Mud Creek (96) and Fivemile Creek (97) projects.
36	West Branch Susquehanna River, at Lock Haven, Pa.	V	Test reliability of hydrologic data and record changes in flow regimen.
32	Conodoguinet Creek, Near Mouth	VII	Control and effects of Shady Grove project (12).
49	Susquehanna River, at Holtwood Dam	VIII	Analysis of lower Main Stem; hydroelectric power generation enhancement.
50	Susquehanna River, above Conowingo Dam	VIII	Analysis of lower Main Stem.
50	Susquehanna River, below Conowingo Dam	VIII	Analysis of lower Main Stem.
51	Susquehanna River, at mouth	VIII	Analysis of lower Main Stem and supply to upper Chesapeake Bay.

Details on the planned operation of the individual projects in the Coordinating Committee Plan are contained in the descriptions in Appendix K(2). Not all the storage in Table 15 in the late action phases (after 1980) are specifically intended for low flow augmentation.

Simulations

The first six simulations were designed for the entire reservoir system for the following conditions:

(1) Present level of surface water storage development with year 1980 demands, losses and ground water effects.

(2) Year 1980 Plan with 1980 demands, losses and ground water effects.

(3) Present level of surface water storage development with year 2000 demands, losses and ground water effects.

(4) Year 2000 Plan with 2000 demands, losses and ground water effects.

(5) Present level of surface water storage development with year 2000 demands, losses and ground water effects.

(6) Year 2020 Plan with 2020 demands, losses and ground water effects.

Simulations 1, 3 and 5 represented the "without" or "base" condition. The purpose of these models was to establish a base for measurement of benefits and to indicate the magnitude of unmitigated consumptive losses. Reflected in the system input, in addition to reservoirs existing or programmed, were continued development of ground water and all projected diversions. Not included, however, were the reservoirs contained in the Coordinating Committee Plan. Output from the program indicated that the "base" condition reservoirs able to augment low flows and continued ground water development would compensate for consumptive losses only slightly during low flow periods.

The result would be a pronounced reduction in natural streamflows, as shown by the figures in Tables 17 through 24 for "minimum recorded" (future) flows. By the year 2020, for instance, the minimum monthly low flow could be less than 200 cubic feet per second (cfs), a flow barely measurable at the River mouth (Table 24). Under these conditions, many critical water supply and water quality shortages would have occurred throughout the Basin, clearly indicating that the Susquehanna would not be able to support such consumptive losses without significant augmentation during low flow periods.

TABLE 17
RESULTS OF SIMULATIONS 1 THROUGH 6 AT CORTLAND
(All Flows In cfs)

Simulation	Condition	Jul	Aug	Sep	Oct
1	1980, without CCP*				
	Average flow	187	133	145	231
	Minimum recorded	32	19	17	10
	Maximum recorded	1,091	740	654	1,005
	95% exceedence	36	25	23	23
2	1980, with CCP				
	Average flow	188	135	145	231
	Minimum recorded	50	47	37	26
	Maximum recorded	1,091	740	654	1,005
	95% exceedence	50	47	37	31
3	2000, without CCP				
	Average flow	176	124	140	227
	Minimum recorded	21	10	12	6
	Maximum recorded	1,080	731	649	1,001
	95% exceedence	25	15	19	19
4	2000, with CCP				
	Average flow	204	144	146	228
	Minimum recorded	99	93	74	51
	Maximum recorded	1,074	731	649	1,001
	95% exceedence	99	93	74	51
5	2020, without CCP				
	Average flow	164	113	134	222
	Minimum recorded	9	0	6	1
	Maximum recorded	1,068	720	643	996
	95% exceedence	13	4	12	14
6	2020, with CCP				
	Average flow	207	163	157	217
	Minimum recorded	158	148	119	84
	Maximum recorded	1,032	694	611	996
	95% exceedence	158	148	119	84

*Coordinating Committee Plan

TABLE 18

RESULTS OF SIMULATIONS 1 THROUGH 6 AT BINGHAMTON

All Flows In cfs)

Simulation	Condition	Jul	Aug	Sep	Oct
1	1980, without CCP				
	Average flow	2,361	1,688	1,940	3,043
	Minimum recorded	388	230	234	145
	Maximum recorded	13,909	9,436	8,364	12,846
	95% exceedence	445	312	315	305
2	1980, with CCP				
	Average flow	2,362	1,690	1,941	3,043
	Minimum recorded	401	257	255	162
	Maximum recorded	13,909	9,436	8,364	12,846
	95% exceedence	460	328	326	325
3	2000, without CCP				
	Average flow	2,263	1,601	1,904	3,013
	Minimum recorded	305	168	219	136
	Maximum recorded	13,809	9,347	8,327	12,816
	95% exceedence	360	245	291	286
4	2000, with CCP				
	Average flow	2,279	1,625	1,908	3,007
	Minimum recorded	405	376	254	165
	Maximum recorded	13,802	9,347	8,327	12,816
	95% exceedence	410	376	360	320
5	2020, without CCP				
	Average flow	2,186	1,538	1,863	2,978
	Minimum recorded	259	131	205	129
	Maximum recorded	13,722	9,270	8,279	12,778
	95% exceedence	315	211	277	277
6	2020, with CCP				
	Average flow	2,275	1,654	1,879	2,952
	Minimum recorded	740	682	485	335
	Maximum recorded	13,680	9,250	8,248	12,778
	95% exceedence	740	682	560	387

TABLE 19
RESULTS OF SIMULATIONS 1 THROUGH 6 AT ELMIRA
(All Flows In cfs)

Simu-lation	Condition	Jul	Aug	Sep	Oct
1	1980, without CCP				
	Average flow	814	647	512	1,122
	Minimum recorded	117	114	120	232
	Maximum recorded	5,188	3,938	1,973	7,593
	95% exceedence	138	121	136	252
2	1980, with CCP				
	Average flow	814	648	513	1,122
	Minimum recorded	121	118	126	237
	Maximum recorded	5,188	3,938	1,973	7,593
	95% exceedence	145	128	140	261
3	2000, without CCP				
	Average flow	801	635	507	1,118
	Minimum recorded	104	102	116	229
	Maximum recorded	5,175	3,926	1,968	7,589
	95% exceedence	127	109	130	252
4	2000, with CCP				
	Average flow	811	653	513	1,115
	Minimum recorded	208	200	178	234
	Maximum recorded	5,175	3,926	1,968	7,532
	95% exceedence	208	200	178	259
5	2020, without CCP				
	Average flow	786	622	498	1,110
	Minimum recorded	89	89	109	224
	Maximum recorded	5,160	3,913	1,959	7,581
	95% exceedence	112	100	120	250
6	2020, with CCP				
	Average flow	838	697	542	1,096
	Minimum recorded	334	320	285	269
	Maximum recorded	5,160	3,913	1.876	7,252
	95% exceedence	334	320	285	269

TABLE 20
RESULTS OF SIMULATIONS 1 THROUGH 6 AT LOCK HAVEN
(All Flows In cfs)

Simulation	Condition	Jul	Aug	Sep	Oct
1	1980, without CCP				
	Average flow	2,713	1,786	1,750	2,668
	Minimum recorded	521	309	340	245
	Maximum recorded	14,955	8,688	9,475	14,661
	95% exceedence	638	403	376	307
2	1980, with CCP				
	Average flow	2,713	1,786	1,751	2,668
	Minimum recorded	523	312	342	247
	Maximum recorded	14,955	8,688	9,475	14,661
	95% exceedence	630	404	378	365
3	2000, without CCP				
	Average flow	2,696	1,772	1,739	2,659
	Minimum recorded	504	295	329	236
	Maximum recorded	14,938	8,674	9,464	14,652
	95% exceedence	624	391	366	301
4	2000, with CCP				
	Average flow	2,696	1,772	1,740	2,659
	Minimum recorded	506	298	331	238
	Maximum recorded	14,938	8,674	9,464	14,652
	95% exceedence	605	391	368	360
5	2020, without CCP				
	Average flow	2,680	1,757	1,728	2,651
	Minimum recorded	488	280	318	228
	Maximum recorded	14,922	8,659	9,543	14,644
	95% exceedence	609	376	356	294
6	2020, with CCP				
	Average flow	2,684	1,762	1,733	2,654
	Minimum recorded	496	289	326	236
	Maximum recorded	14,918	8,659	9,441	14,642
	95% exceedence	600	384	364	355

TABLE 21
RESULTS OF SIMULATIONS 1 THROUGH 6 AT HARRISBURG WEST SHORE
(All Flows In cfs)

Simulation	Condition	Jul	Aug	Sep	Oct
1	1980, without CCP				
	Average flow	293	245	209	254
	Minimum recorded	46	38	7	37
	Maximum recorded	1,578	1,197	908	999
	95% exceedence	76	52	37	44
2	1980, with CCP				
	Average flow	293	245	209	254
	Minimum recorded	46	40	25	40
	Maximum recorded	1,578	1,197	908	999
	95% exceedence	70	52	40	45
3	2000, without CCP				
	Average flow	280	233	200	247
	Minimum recorded	33	26	0	30
	Maximum recorded	1,565	1,185	899	992
	95% exceedence	62	37	28	38
4	2000, with CCP				
	Average flow	281	233	200	247
	Minimum recorded	39	38	33	33
	Maximum recorded	1,565	1,185	899	992
	95% exceedence	62	38	33	37
5	2020, without CCP				
	Average flow	238	195	181	231
	Minimum recorded	0	0	0	14
	Maximum recorded	1,522	1,146	880	976
	95% exceedence	9	0	8	23
6	2020, with CCP				
	Average flow	250	214	191	233
	Minimum recorded	99	95	83	78
	Maximum recorded	1,522	1,146	880	976
	95% exceedence	99	95	83	78

TABLE 22
RESULTS OF SIMULATIONS 1 THROUGH 6 AT HOLTWOOD DAM
(All Flows In cfs)

Simulation	Condition	Jul	Aug	Sep	Oct
1	1980, without CCP				
	Average flow	17,229	13,352	12,759	17,939
	Minimum recorded	3,776	2,809	2,812	2,862
	Maximum recorded	77,933	50,703	43,364	62,050
	95% exceedence	5,419	3,852	3,476	3,630
2	1980, with CCP				
	Average flow	17,239	13,366	12,773	17,947
	Minimum recorded	3,807	2,850	2,866	2,899
	Maximum recorded	77,924	50,701	43,368	62,047
	95% exceedence	5,600	4,200	3,620	3,800
3	2000, without CCP				
	Average flow	16,632	12,800	12,379	17,592
	Minimum recorded	3,205	2,286	2,465	2,531
	Maximum recorded	77,334	50,148	42,983	61,704
	95% exceedence	4,844	3,338	3,122	3,307
4	2000, with CCP				
	Average flow	16,876	12,842	12,385	17,674
	Minimum recorded	3,351	2,479	2,581	2,569
	Maximum recorded	77,325	50,114	42,987	61,602
	95% exceedence	5,130	3,800	3,300	3,500
5	2020, without CCP				
	Average flow	15,681	11,912	11,673	16,926
	Minimum recorded	2,345	1,482	1,830	1,941
	Maximum recorded	76,369	49,215	42,266	61,007
	95% exceedence	3,941	2,524	2,470	2,702
6	2020, with CCP				
	Average flow	15,851	12,144	11,766	16,904
	Minimum recorded	3,131	2,260	2,238	2,080
	Maximum recorded	76,350	49,180	42,245	60,457
	95% exceedence	4,700	3,400	2,800	3,100

TABLE 23
RESULTS OF SIMULATIONS 1 THROUGH 6 AT CONOWINGO DAM
(All Flows In cfs)

Simulation	Condition	Jul	Aug	Sep	Oct
1	1980, without CCP				
	Average flow	17,209	13,318	12,753	17,988
	Minimum recorded	3,525	2,506	2,613	2,644
	Maximum recorded	78,408	52,544	44,115	62,702
	95% exceedence	5,204	3,624	3,292	3,504
2	1980, with CCP				
	Average flow	17,219	13,332	12,767	17,996
	Minimum recorded	3,556	2,547	2,667	2,681
	Maximum recorded	78,399	52,543	44,119	62,700
	95% exceedence	5,300	4,000	3,500	3,550
3	2000, without CCP				
	Average flow	16,118	12,294	11,965	17,257
	Minimum recorded	2,460	1,510	1,858	1,929
	Maximum recorded	77,315	51,516	43,326	61,972
	95% exceedence	4,125	2,666	2,566	2,833
4	2000, with CCP				
	Average flow	16,358	12,320	11,961	17,333
	Minimum recorded	2,607	1,702	1,974	1,967
	Maximum recorded	77,306	51,483	43,330	61,870
	95% exceedence	4,300	3,090	2,620	3,000
5	2020, without CCP				
	Average flow	14,633	10,895	10,824	16,182
	Minimum recorded	1,066	195	787	930
	Maximum recorded	75,816	50,074	42,173	60,866
	95% exceedence	2,680	1,350	1,519	1,870
6	2020, with CCP				
	Average flow	14,803	11,128	10,917	16,159
	Minimum recorded	1,852	974	1,157	1,069
	Maximum recorded	75,797	50,083	42,152	60,316
	95% exceedence	3,500	2,220	1,820	2,000

TABLE 24
RESULTS OF SIMULATIONS 1 THROUGH 6
AT THE MOUTH OF THE SUSQUEHANNA RIVER
(All Flows In cfs)

Simulation	Condition	Jul	Aug	Sep	Oct
1	1980, without CCP				
	Average flow	17,649	13,718	13,104	18,386
	Minimum recorded	3,653	2,540	2,702	2,681
	Maximum recorded	79,519	55,483	45,490	63,918
	95% exceedence	5,362	3,711	3,382	3,599
2	1980, with CCP				
	Average flow	17,660	13,732	13,118	18,394
	Minimum recorded	3,684	2,581	2,749	2,717
	Maximum recorded	79,510	55,481	45,495	63,915
	95% exceedence	5,500	4,100	3,550	3,930
3	2000, without CCP				
	Average flow	16,503	12,643	12,312	17,655
	Minimum recorded	2,533	1,494	1,926	1,966
	Maximum recorded	78,371	54,405	44,697	63,188
	95% exceedence	4,228	2,710	2,641	2,936
4	2000, with CCP				
	Average flow	16,742	12,662	12,303	17,729
	Minimum recorded	2,680	1,687	2,046	2,004
	Maximum recorded	78,362	54,371	44,702	63,086
	95% exceedence	4,600	3,190	2,690	3,100
5	2020, without CCP				
	Average flow	15,003	11,232	11,169	16,580
	Minimum recorded	1,124	167	851	967
	Maximum recorded	76,857	52,949	43,543	62,082
	95% exceedence	2,762	1,380	1,599	1,963
6	2020, with CCP				
	Average flow	15,173	11,464	11,263	16,557
	Minimum recorded	1,910	935	1,191	1,106
	Maximum recorded	76,838	52,914	43,523	61,531
	95% exceedence	3,500	2,270	1,850	2,180

Simulations 2, 4 and 6 superimposed the time-phased Coordinating Committee Plan on the three "base" systems, operating each project selection for its local (upstream) purposes only. The minimum monthly low flow based on 2020 conditions under this analysis would approach 900 cfs at the mouth of the Susquehanna River, a figure still substantially less than the minimum historically recorded for any month. There would be, however, no significant water supply or quality management shortages, except on the lower Main Stem, downstream from Conowingo Dam, where a water quality shortage exceeding 1700 cfs would be recorded. In these three simulations, the projects recommended in the Coordinating Committee Plan were not specifically operated to satisfy the requirements of the lower Main Stem except as an incidental effect. Results of the six "with and without" simulations are summarized in Tables 17 through 24 for a number of important locations in the Basin.

Four additional simulations were made in which the 2020 Coordinating Committee Plan is superimposed on the 2020 base system. In these latter simulations, all reservoirs which would contain conservation storage (see Tables 14 and 15) were operated for both the upstream need center (control point) and for the requirements of the lower Susquehanna River and Chesapeake Bay. Wherever a reservoir project included in the year 2020 simulations contained conservation storage not specifically allocated to low flow augmentation, this storage was assumed to be available to determine the augmentation capability.

The purposes of Simulations 7, 8, and 9 were twofold. The first was to determine if the water quality management criteria in the lower Main Stem could be satisfied by altering the pattern of regulation of the existing and proposed reservoir projects. These criteria are (1) to maintain a dissolved oxygen concentration of at least 5.0 milligrams per liter (mg/l) in the River downstream from Conowingo Dam, and (2) to maintain a monthly flow into the upper Chesapeake Bay at least equal to the minimum recorded monthly flow (see Appendix B, Maryland).

The second purpose of Simulations 7, 8, and 9 was to test the sensitivity of the water quality management capability of these reservoirs to increases in the total diversions and consumptive losses as shown in Table 25.

TABLE 25
ASSUMED DIVERSIONS AND LOSSES
IN SIMULATIONS 7, 8, AND 9

Simulation Number	Average Year 2020 Total Diversions And Losses (in cfs)
7	2240
8	3660
9	5100

The results of Simulations 7, 8, and 9 indicated that, based on an average total loss of 2,920 cfs, which is the current estimate for the year 2020, the existing and proposed reservoirs could be operated for the water quality management of the lower Main Stem in addition to providing for local low flow augmentation needs. About 50 percent of the conservation storage in both existing and proposed reservoirs would be required to satisfy the water quality criteria described above, assuming the unlikely case that all storage would be equally available. For the range of total losses investigated in Simulations 7, 8, and 9, the required storage varies from about 40 percent to 110 percent of the conservation storage in both existing and proposed reservoirs.

Simulation 10 determines the maximum monthly flow, at and downstream from the Conowingo Dam, which can be maintained if existing reservoirs and the reservoirs in the 2020 Coordinating Committee Plan are operated as in Simulations 7 through 9. Based on an average total consumption and diversion loss of 2,920 cfs, the maximum monthly flow which can be maintained is 4,300 cfs. This result is based on the assumption that future hydrologic conditions in the Susquehanna basin will be similar to those of the 68 years of record used in this analysis.

Conclusions

There are four conclusions which may be made based on the results of the 10 simulations.

(1) The reservoirs recommended in the Coordinating Committee Plan are adequate to satisfy the local upstream needs for low flow augmentation for which they are designed and intended.

(2) Operation of these projects, together with the existing reservoirs, as planned for the upstream areas, would not fully compensate for the cumulative effect of consumptive losses on the lower Main Stem during the late action period.

(3) Operation of about half of the existing and proposed year 2020 surface storage, if assumed available, could satisfy all in-Basin low flow augmentation purposes, including a minimum dissolved oxygen concentration in the lower main stem of 5.0 mg/l and a monthly flow below Conowingo Dam at least equal to the minimum recorded monthly flow.

(4) A minimum flow of about 4,300 cfs can be maintained at Conowingo Dam if all existing and proposed storage is managed for the lower Main Stem, in addition to individual project purposes. This could be available to compensate for unforseen diversions out of the Basin, or consumptive losses in excess of the projected total, assuming that the Chesapeake Bay requirements for fresh water inflow are <u>no greater</u> than that established by the past history of minimum flows of the Susquehanna River.

B. FLOOD CONDITIONS

The Coordinating Committee Plan contains six major reservoir projects with storage reserved specifically for flood damage reduction. The projects are listed in Table 26 for the Plan year intended for implementation and by sub-basins; their locations are shown on Figures 14 and 17 in Chapter X. Detailed information on each project is presented in Appendix K(2).

TABLE 26
MAJOR RESERVOIRS IN COMPREHENSIVE PLAN
WITH FLOOD CONTROL STORAGE

Plan Year	Sub-basin	Project Name	Inventory Number	Storage Acre-Feet	Drainage Area Sq. Mi.
1980	I	Charlotte Creek	121	44,000	164.0
1980	I	Fabius	49-28	10,000	36.4
1980	I	South Plymouth	114	17,000	57.0
1980	II	Fivemile Creek	97	18,000	66.0
1980	II	Mud Creek	96	10,000	75.0
2000	I	East Guilford	115	70,000	523.0

These projects would become an integral part of the existing and programmed flood control system (see Appendix E) for the portion of the Basin located upstream from the confluence of the Susquehanna River and the West Branch, or all of Sub-basins I, II, and III.

Although the maximum flood reductions occur at locations immediately downstream from each of the additional projects, measurable reductions in flood stage and peak discharge would also occur on the Susquehanna River at least as far downstream as Danville, Pennsylvania, near the mouth of Sub-basin III.

The effects of the flood storage allocations contained in the six reservoir projects shown in Table 26 were evaluated by simulating the operation of the total system (see Chapter III) as planned for 1980 and for 2000. (No major flood storage is indicated in the Coordinating Committee Plan for implementation beyond the year 2000.) A range of hypothetical floods was computed to determine the reduction of flood flows due to each of the six additional projects. The effects of the existing, 1980, and the 2000 systems on the largest floods of record at selected points in Sub-basins I & II are shown in Table 27. Note that the East Guilford project would be the most effective single reservoir for the Susquehanna River in New York. The effects of the same systems on the Standard Project Floods (SPF) at Binghamton, New York, and at Wilkes-Barre, Pennsylvania, are listed in Table 28, as well as the percentages of the modified SPF in relation to the discharge capacity of the local flood protection systems. Again, the East Guilford project is the most effective single reservoir in providing a more adequate degree of protection against a major flood overtopping the Binghamton flood walls, as measured by the percentage of the Standard Project Flood.

TABLE 27

LARGEST FLOOD OF RECORD AT SELECTED STATIONS
MODIFIED BY MAJOR FLOOD CONTROL RESERVOIRS

Location	Drainage Area (Sq. Mi.)	Year of Flood	Peak Flow of F.O.R. (cfs)	Modified F.O.R. (cfs)	Reduction (Ft)	Effective Flood Control Reservoirs*	Percent Reduction of Peak Flow
Susquehanna River, at Oneonta, N.Y.	686	1960	20,000	13,000	3.6	C	35
Chenango River at Greene, N.Y.	598	1935	27,500	25,000	1.0	D	9
Chenango River at Chenango Forks, N.Y.	1,492	1935	96,000	77,000	2.9	B	20
				72,000	3.6	B,D,E	25
Susquehanna River at Vestal, N.Y.	3,960	1936	107,000	93,000	2.0	A,B	13
				88,000	3.3	A thru E	18
				70,000	6.5	A thru E & H	35
Cohocton River at Campbell, N.Y.	472	1935	**41,100	**27,000	**1.1	F,G	34

* Effective Reservoirs
- A. East Sidney
- B. Whitney Point
- C. Davenport Center
- D. South Plymouth
- E. Fabius
- F. Fivemile Creek
- G. Mud Creek
- H. East Guilford

** Based on extended stage-discharge rating; topographic nature of flood plain at this location indicates relatively low stage reduction for larger floods.

TABLE 28

NATURAL AND MODIFIED STANDARD PROJECT FLOOD (SPF)

Location	Drainage Area (Sq. Mi.)	Natural S.P.F. (cfs)	Natural %*	Mod. (cfs)	%*	Effective Res.**	1980 Plan Mod. (cfs)	1980 Plan %*	1980 Plan Effective Res.**	2000 Plan Mod. (cfs)	2000 Plan %*	2000 Plan Effective Res.**
Susquehanna River at Binghamton, N.Y. (Above Jct. with Chenango River)	2,280	198,000	40	183,000	44	A	175,000	46	A,C	118,000	68	A,C,H
Susquehanna River at Wilkes-Barre, Pa.	9,960	490,000	50	414,000	59	A,B, & I thru N	405,000	61	A thru G & I thru N	392,000	63	A thru N

** Effective Reservoirs

	Base	1980	2000
A. East Sidney	X	X	X
B. Whitney Point	X	X	X
C. Davenport Center		X	X
D. South Plymouth		X	X
E. Fabius		X	X
F. Fivemile Creek		X	X
G. Mud Creek		X	X
H. East Guilford			X
I. Arkport	X	X	X
J. Almond	X	X	X
K. Tioga-Hammond	X	X	X
L. Cowanesque	X	X	X
M. Stillwater	X	X	X
N. Aylesworth	X	X	X

* Percent of flow at top of levee to the S.P.F.

Binghamton, N.Y.
Flow at top of wall - 80,000 cfs

Wilkes-Barre, Pa.
Flow at top of levee - 246,000 cfs under existing conditions of subsidence